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ABSTRACT

This publication contains the energy education materials for middle schools from project ENCORE (Energy Conservation Resources for Education). These modules were originally field tested in Texas schools during the 1976-77 academic year. The revised materials in this publication are organized into four major units and thirteen chapters. The chapters provide objectives, informational coverage of topics, activities, and vocabulary lists for students. "Suggestions to the Teacher" sections provide lists of materials, tests, scoring keys, resource lists, and media aids suggestions. The information and activities were designed for use in middle and junior high school industrial arts and science classes. These materials can also be used in other subject areas when exploring energy-related topics. The four major sections are: (1) Introduction; (2) Energy Sources and Energy Production; (3) Energy Conservation; and (4) Alternative Energy Sources. Chapter titles include: (1) Energy in Texas; (2) Environmental Quality and Energy; (3) Energy Saving Tips; (4) Solar Energy; (5) Unusual Energy Sources; and (6) Grow Your Own Garden. Although the materials were written for use in Texas, they may easily be adapted to other areas. (Author/MR)

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ENCORE

Energy Conservation Resources For Education

Department of Industrial Education, Texas A&M University
College Station, Texas 77843

SE 025 401

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INTRODUCTION

Whether individuals squander energy resources through ignorance or inefficiency, the ultimate results are universal in effect. It is important, therefore, that an attempt be made to improve American's understanding of energy-related concepts and to increase their motivation to conserve energy resources and to utilize them wisely.

If the educational program on energy conservation is to have maximum value, it should begin prior to the time individuals become heavy users (and wasters) of energy, yet, the concepts are not readily understood by the very young. Educational experiences must be designed for use by all students in their on-going curriculum. With this thought, project ENCORE (Energy Conservation Resources for Education) was created. As a part of the activities of the Center for Energy and Mineral Resources, the College of Education organized an effort in instructional materials development for the middle schools of Texas. Middle school teachers worked with consultants during the three-week session, June 1 through June 18, 1976, to develop a series of energy-related instructional modules for use by students and teachers in several school subjects.

The ENCORE modules were field tested in Texas schools during the academic year, 1976-77. Teachers and students who used the modules were asked to provide suggestions and make comments. From their input, substantial revisions were made in ENCORE materials during the spring of 1977. Material was modified, rearranged, refined and deleted. Content coverage was expanded where field testing indicated the need for additional activities or expository treatments.

The materials were designed for use at the middle school and junior high school level. Consequently, there is substantial range in difficulty levels among the content, activities, and vocabulary. Information and activities have been field tested in and are appropriate for industrial arts classes, science classes, or other classes exploring energy-related topics.

The revised materials from the 1976 ENCORE modules have been grouped into four major units. The thirteen chapters provide objectives, informational coverage, activities, and vocabulary lists for students. Teachers will want to refer to the "Suggestions to the Teacher" sections for lists of materials, tests, scoring keys, resource lists, and media.

As the materials are set in "final" form, it is most appropriate to express words of appreciation to those whose actions have encouraged our efforts. The Center for Energy and Mineral Resources at Texas A&M University has provided funding for the project throughout its twenty-month existence. Dr. Stephen Riter, Associate Director of the Center for Energy and Mineral Resources, has been especially helpful, and other CEMR staff members have facilitated ENCORE activities. Dr. Frank W. R. Hubert, Dean of the College of Education, Dr. Donald L. Clark, Associate Dean for Research, College of Education, and Dr. James L. Boone, Jr., Head of the Department of Industrial Education have at all times provided the physical and material support necessary for the accomplishment of project goals.

The ENCORE Steering Committee, Judy Hendricks, Sammy Hollis, Bill Duncan, Walter Tillman, Mike Scott, Mike Hart, Delmar Janke, Glenn Johnson, and Karl Koenig gave many helpful suggestions in planning the workshop and project activities.

The enthusiastic performance of the eighteen participants in the 1976 ENCORE workshop resulted in the first draft of the instructional materials which are included here. Our thanks to them - and our apologies if we have made modifications not to their liking. They were Glen L. Anderson, Dorothea Basnett, Larry Carlton, Betty R. Elvin, Virginia D. Gibeson, Gilbert Griffin, David Hughes, Michael Kozelsky, Hugh Lovett, Lynda McAtee, Charles C. McLemore, Judy McPherson, James D. Partain, Dorothy F. Sanders, Eloise H. Schubert, Ollie V. Smith, Winfred Talley, and Juanda C. Winkler. Financial support for participants was provided by the Governor's Energy Advisory Council.

Revisions and field testing have required the efforts of several individuals directly affiliated with the project. William H. Mast, Richard A. Meznarich, David McCampbell, Evalyn Worley, Nancy Lancaster, and Dan Langen have fulfilled a number of roles including editorial work, artwork, photography, and proofreading. A special thanks to Donna Campbell for her dedicated service throughout the project's activities.

Dr. Daniel L. Householder
Project Director

C

ENCORE

Chapter 1

Energy Conservation Resources For Education
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OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. determine which five forms of electrical energy production are used most in the United States at the present time.
2. determine which parts of American society consume the most energy.
3. list the various sources of energy used at different stages in human history
4. recognize examples of the conversion of energy from one form to another.
5. define a list of vocabulary words related to energy.

AN INTRODUCTION TO ENERGY

All energy (except nuclear energy) comes from the sun, either directly or indirectly (Figure I-1). Prehistoric plants stored the sun's energy and, through time, those plants were pressed together to form oil, natural gas, or coal. The sun also causes precipitation, evaporation and the changes in climate. Therefore, any energy from river currents, tides, waves or winds come indirectly from the sun. Recently, man has devised ways to process direct solar cells and growing things. Because we, as energy-users, are benefited by stored-indirect and direct solar energy, we should learn all we can about energy.

According to the Law of Conservation of Energy: Energy cannot be created nor destroyed by ordinary means; it can merely change from one form to another. Heat, light, electricity, motion, chemical reactions and nuclear reactions are forms of energy. Figure I-2 gives examples of energy conversions. Try to think of some of your own examples.

Man and Energy

Man cannot exist without energy; he has always had some available source of energy. Primitive man was equipped with built-in muscle power which was an effective tool. His tools were his hands with thumbs opposing his fingers, enabling him to grasp things easily, and a creative mind which could grasp ideas. Like a modern computer, his mind could store information and recall it for later use.

Early man had the good fortune to live on a planet with almost inexhaustible energy sources. Some of these, such as volcanoes, lightning, geysers, tornadoes and hurricanes, were unusual to him. He either feared

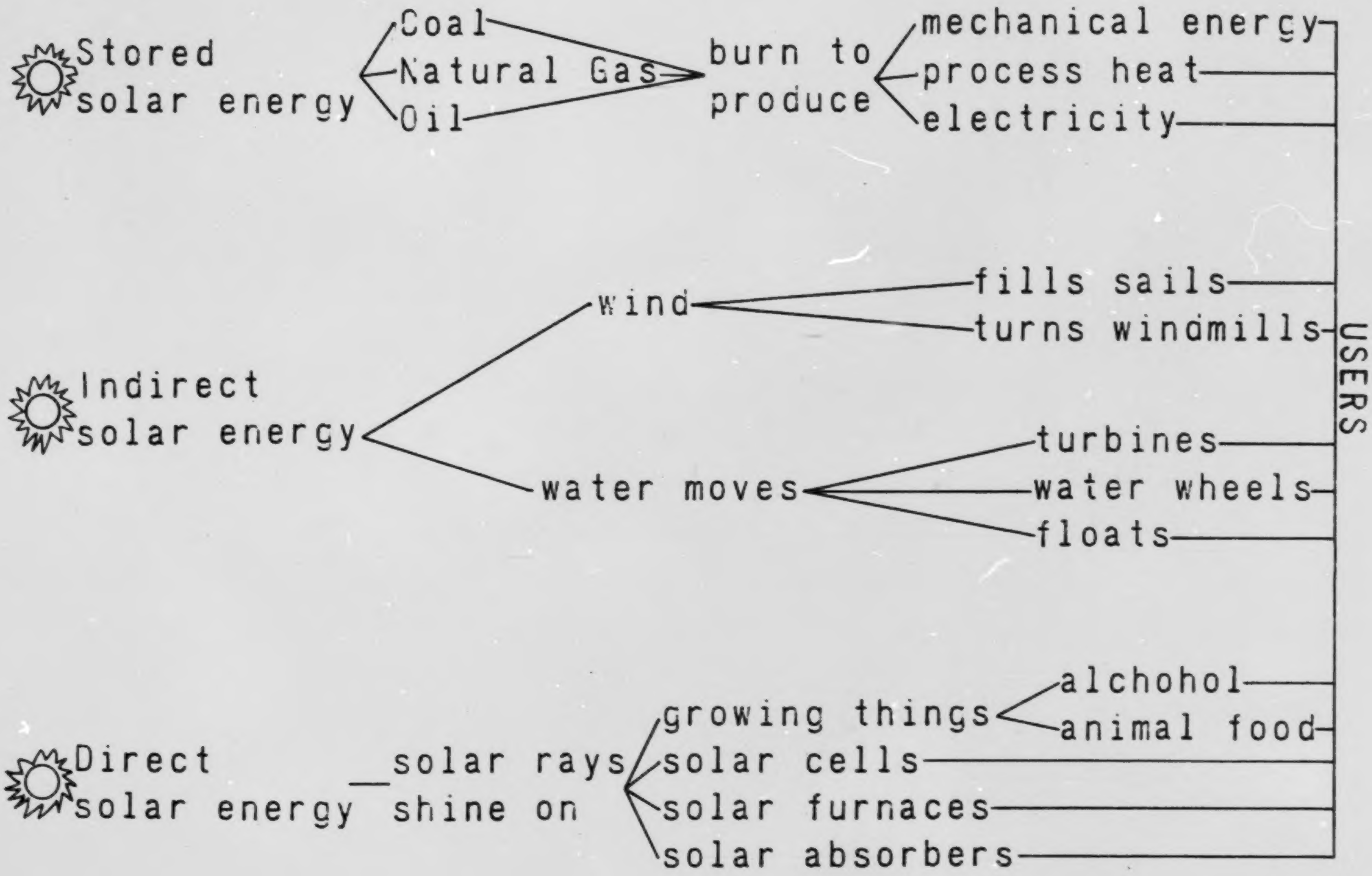

Stored solar energy
Coal
Natural Gas
Oil
burn to produce
mechanical energy
process heat
electricity
Indirect solar energy
wind
fills sails
turns windmills
water moves
turbines
water wheels
floats
Direct solar energy
solar rays shine on
growing things
alchohol
animal food
solar cells
solar furnaces
solar absorbers
USERS

Figure I-1

Conversion	Example
Heat to light	Incandescent bulb
Heat to electricity	Thermocouple
Heat to chemical reaction	Processing most ore
Heat to nuclear reaction	The sun
Heat to mass-in-motion	Wind
Light to heat	Focusing sun rays with lens
Light to electricity	Photovoltaic cell
Light to chemical reactions	Photosynthesis
Mass-in-motion to heat	Playground slide or carpet burns
Mass-in-motion to electricity	Hydroelectric turbine
Nuclear reactions to heat	Power reactor or heart pacemaker
Nuclear reactions to electricity	"Beta" radiation produces direct flow of electricity
Nuclear reactions to chemical	Use of radiation to speed up polymerization of plastic
Chemical reactions to electricity	Any battery
Chemical reactions to light	Bioluminescence of "lightning bugs"
Chemical reactions to heat	Burning coal
Chemical reactions to mass-in-motion	Explosion of TNT

Figure I-2

(Adapted from page 12, "So What's New," ERDA, Office of Public Affairs) or worshipped these forces. Others he began to understand, and as he understood them, he learned to "tame" and use them to help him do work.

He satisfied his immediate needs by searching for food. As food became scarce in one area, he migrated to another. By inventing hand tools, he extended his body so it could perform more effectively in securing food.

He learned to harness fire to heat his home, cook his food and protect himself from wild animals.

He discovered that he could train certain animals to help share his work of carrying loads and tilling the soil. Man changed from being a nomadic food gatherer to a settled farmer.

He captured the motion of the water to float logs and rafts downstream and the wind to sail his boats. He invented the wheel to help move heavy objects. He combined his knowledge of water and wheels to make waterwheels and of wind and wheels to make windmills.

Man soon learned to save energy by building dams to store water to run his waterwheels. This stored energy is called potential energy. The energy of motion, such as the flowing water, is called kinetic energy.

Man is never satisifed; to save himself work, he captured slaves. He also improved on simple tools and, by combining them into complex machines, found these helped him so much he did not need slaves. There was more time to enjoy life. Each successful invention and each newly discovered principle led to further advances. What had once seemed impossible now became possible. The unusual became commonplace.

Progress in power development moved slowly. Still by 2000 B.C., agricultural man had water power, wind power, coal for heating and beasts of burden. In the 18th and 19th centuries man became more inventive. Progress depended upon the resources available, creative design and technology to make these ideas and designs work economically.

Man and Energy Sources

The avalanche had started. As man discovered new scientific principles, many discoveries led to whole new fields. New inventions were created for the new field, and the inventions were marketed and used across the country. For example, in 1823, Otto and Langen invented the gas-powered 4-stroke engine. This one advancement led to the invention of diesel engines, jet engines, gas turbines and hundreds of other machines. Oil industries, automobile manufacturers and our national highway system have grown from the base of that one initial advancement.

Man, through his inventions and advancements, is using up the world's resources at a faster and faster rate. We can hope though, that as the oil and natural gas are used up, researchers will discover new energy sources before it is too late.

In 1976, oil was the greatest source of American energy (Figure I-3). Natural gas provided about one-third of the energy supply. Coal, hydroelectric energy, and nuclear energy provided the rest.

But, our oil and natural gas are running out, and coal is a major pollutant. In the future, nuclear and solar energy may be the major sources of American energy, unless someone comes up with a superior energy source.

Man and Energy Consumption

While these various machines and theories were being invented, man also learned to generate, transmit, control, and use electricity. Electricity and electrical appliances became necessary commodities for modern man. By 1980-85, electric utilities will consume the greatest percentage of U.S. energy (Figure I-4). Transportation will use the second greatest

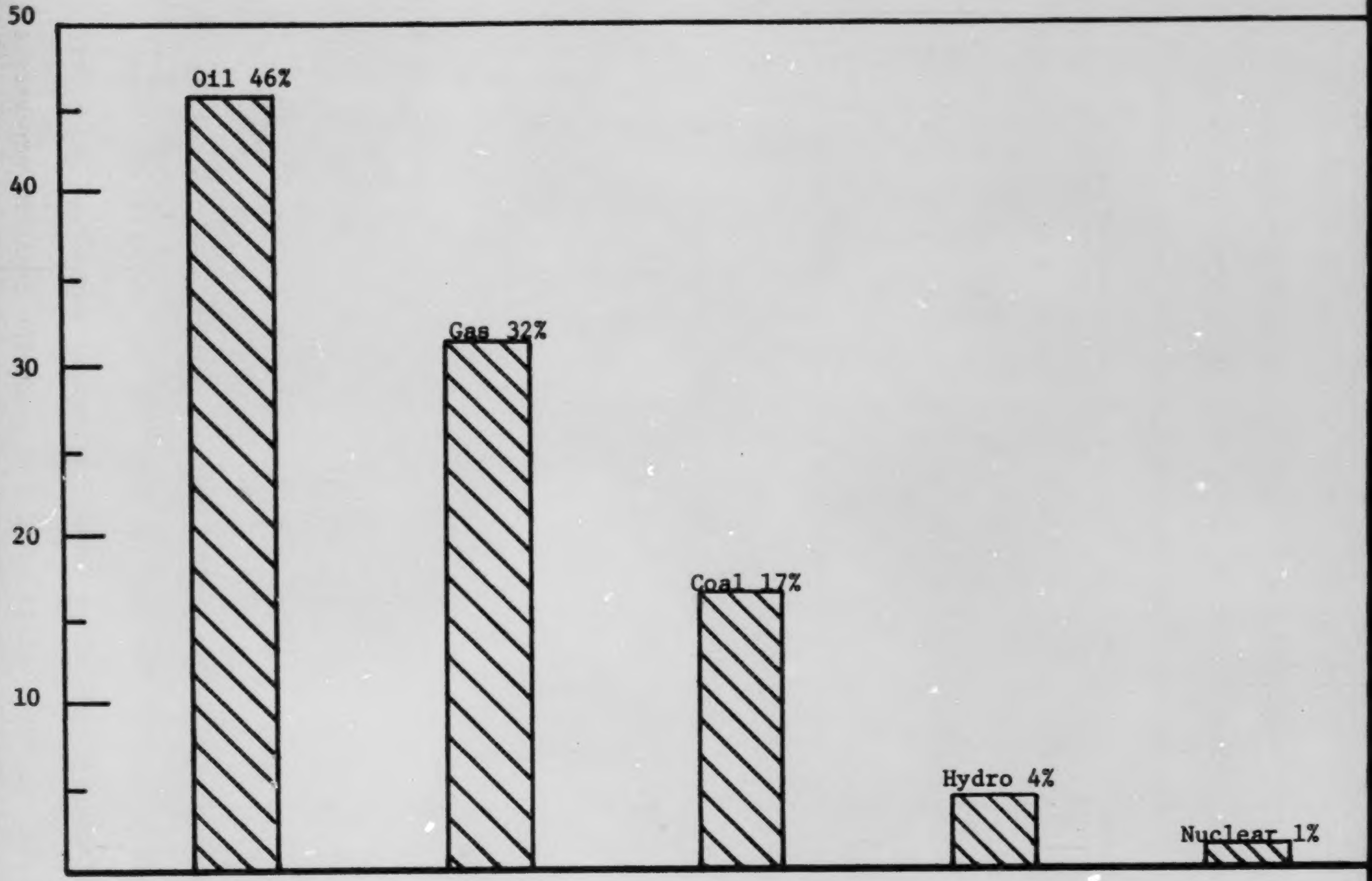


Figure I-3

Sources of American Energy - 1976

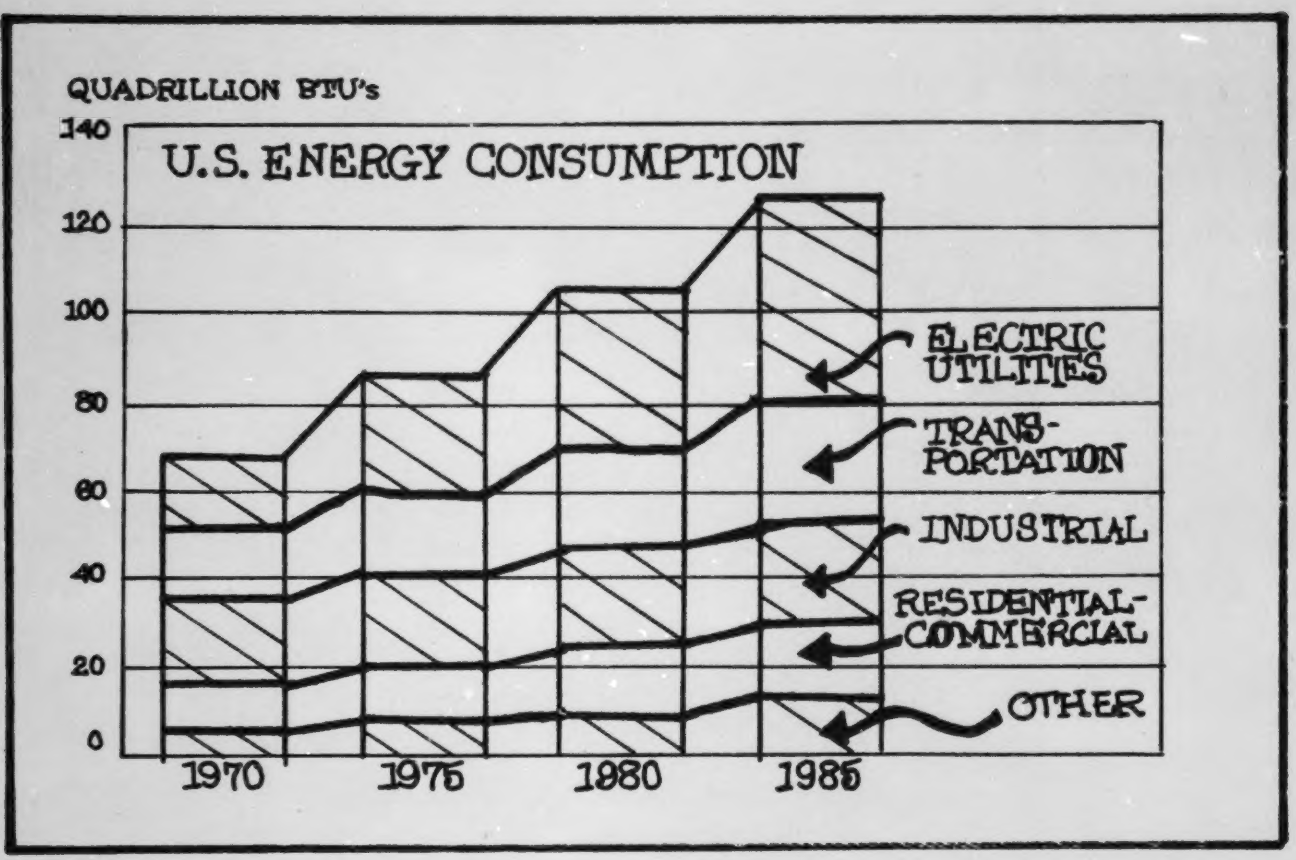

QUADRILLION BTU's
U.S. ENERGY CONSUMPTION
140
120
100
80
60
40
20
0
1970
1975
1980
1985
ELECTRIC UTILITIES
TRANS-PORTATION
INDUSTRIAL
RESIDENTIAL-COMMERCIAL
OTHER

Figure I-4

percentage of U.S. energy. Industrial plants and factories, residential and commercial facilities and many other aspects of the American society will absorb the rest of the U.S. energy supply.

One-half of the energy consumption in man's history has been in the last 100 years due to inventions, increasing population, and man's demand for a better life. How much farther can we go?

Our domestic supplies of oil and natural gas are being used rapidly. We are becoming increasingly dependent upon imported energy sources. This can cause serious international and political problems.

Production of energy sources is limited by environmental quality standards. Public protests have stopped plant construction in some cases, delayed it in others and caused new fuel and operating regulations to be imposed on already harassed industries.

Until recently, the United States was not developing new sources of energy fast enough to keep up with increasing demands, thus the "energy crisis."

Actually, today the United States has more available energy than any other country, not because we have more resources (we don't), but because we use our resources effectively. Thanks to researchers, we have had fuels in the past. We now count on researchers to use their imagination and skill to develop or create new resources before traditional energy sources run out. Meanwhile, we must conserve what we already have by using it as efficiently as possible. We must emphasize use of renewable resources instead of concentrating on non-renewable ones.

> Three hundred years ago coal wasn't a resource, it was just a rock. A hundred years ago oil was a sticky nuisance, not a resource. Coal, oil, and uranium became resources because the mind of man figured out a way to use them beneficially. There is only one real resource in the world: the mind of man . . .
>
> -- Ben Wattenberg. *The Real America*

Solutions

Three solutions for overcoming the energy crisis have been suggested: (1) non-solid fuel conservation, (2) greater use of solid fuels--coal and uranium, and (3) research and development of new fuels. Conservation is essential because research and development take time. Successful development of new fuels will require many years. Better conservation in the use of existing fuels depends upon *you*.

ACTIVITIES

1. Try a "Day Without Energy" (Activity I-1). Read the instructions carefully and talk about the activity with your teacher. The whole class can do this activity together.
2. Watch the slide presentation "Energy and Man" with your class. Complete the questions on Activity I-2. The questions ask about the graphs in Figures I-5 and I-6.
3. Define the vocabulary words. Some of the words you probably already know. Some can be found in the information section. You may have to look up some words in the dictionary (Activity I-3).
4. Find the vocabulary words in the "Energy Seek Puzzle" (Activity I-4).
5. Watch the slide presentation "An Introduction to the Energy Crisis" (Activity I-5).

Day Without Energy

(Activity I-1)

After school or on a Saturday, spend at least part of a day without using any energy at all. The only rule you have to follow is: do not consume any commercially-produced energy for as long as you can. That means do not use any electricity, gasoline, petroleum products or natural gas. No television, radio, air-conditioning, cooking in the kitchen, cars or electric lights!

Look at the points list. Everyone starts out with 1,000 points. If you consume energy, you subtract points. If you do not use energy, add points to your total. If you and your teacher can add anything to the list of points, do this before you start your "Day Without Energy."

Be sure to keep a record of your points so you can take them to class the next day. Have a class discussion and find out if anything unusual happened to your friends on their "Day Without Energy." Then have a contest. The person with the highest score wins!!

If someone conserves energy in an unusual way and it is not on the point list, decide how many points he should get and be sure to give them to him.

This activity can be a fun activity, but it takes some consideration and thinking. Remember, while this is a fun activity, the main idea is to save energy and not just to win a game. Don't be afraid to give your friends points for conserving energy, but the whole class must decide how many extra points are given for what. Have fun!

Points List

Subtract 500 points if you rode in a car out of town.

Subtract 200 points if you rode in a car around town.

Subtract 100 points if you used:

hot water, the refrigerator or freezer, the air conditioner, or range

Subtract 50 points if you used:

the clothes dryer or color television

Subtract 25 points if you used:

black and white television, electronic air cleaner, dishwasher, microwave oven, or furnace

Subtract 10 points if you used:

broiler, coffee maker, window fan, frying pan, electric lights, portable electric heater, record player, or washing machine

Subtract 5 points if you used:

deep fat fryer, radio, trash compactor, small fan, toaster, mixer vacuum cleaner, blender, electric clock, hair dryer, infrared heater, garbage disposal, carving knife, sewing machine, sun lamp, electric razor, or electric toothbrush

Add 400 points if you used water from a source other than the faucet.

Add 250 points if you rode a bicycle instead of a car.

Add 200 points if you ate fresh food instead of processed, packaged, or preserved food.

Add 200 points if you used a solar cooker to prepare a meal.

Add 100 points if you used candles or lanterns instead of conventional lights.

Add 100 points for each hour during which you consumed no commercially-produced energy.

*Can you think of any other ways to earn points?

Reading Graphs

(Activity I-2)

Refer to the graphs in Figures I-5 and I-6 to answer these questions.

1. What was the most important source of energy at the time of the Civil War?

____

2. What was the most important energy source about 1925? ______________

1950? ______________ 1970? ______________

3. What is predicted to be the most important source of energy in 1985?

______________ 2000? ______________

4. What could account for the drop in coal production in the early 1970's?

____

5. Which energy source is expected to increase the greatest percentage between 1980 and 2000?

____

6. How many years did it take for the population to double from:

1/4 to 1/2 billion? ______________

1/2 to 1 billion? ______________

1 to 2 billion? ______________

2 to 4 billion? ______________

3 to 6 billion? ______________

7. How has the pattern changed from 1850? ______________

1975? ______________

8. What is the shape of the curve from 1975 on? ______________

9. What is the predicted population for the year 2000? ______________

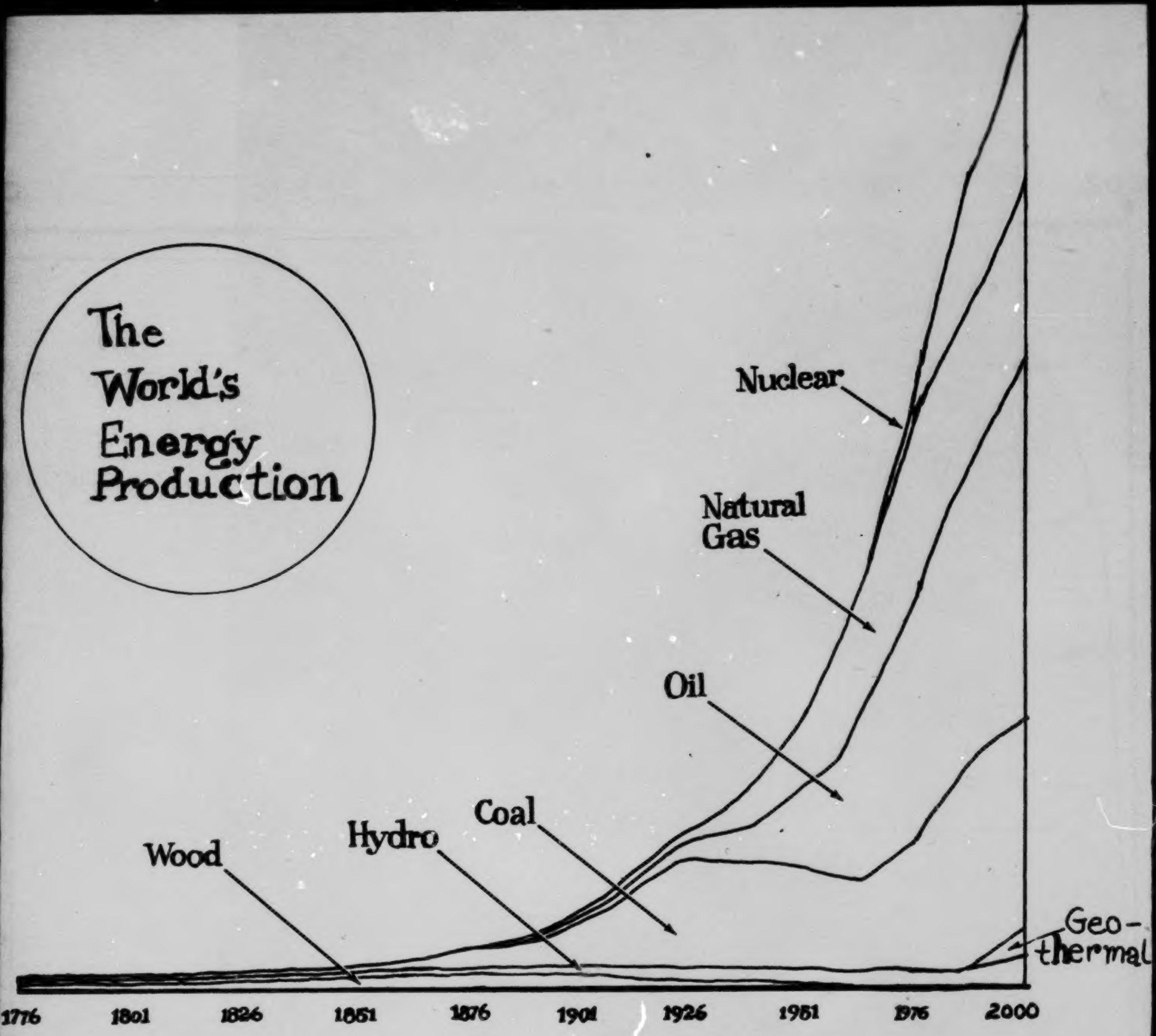

The World's Energy Production
Nuclear
Natural Gas
Oil
Coal
Hydro
Wood
Geo-thermal
1776
1801
1826
1851
1876
1901
1926
1951
1976
2000

Figure I-5

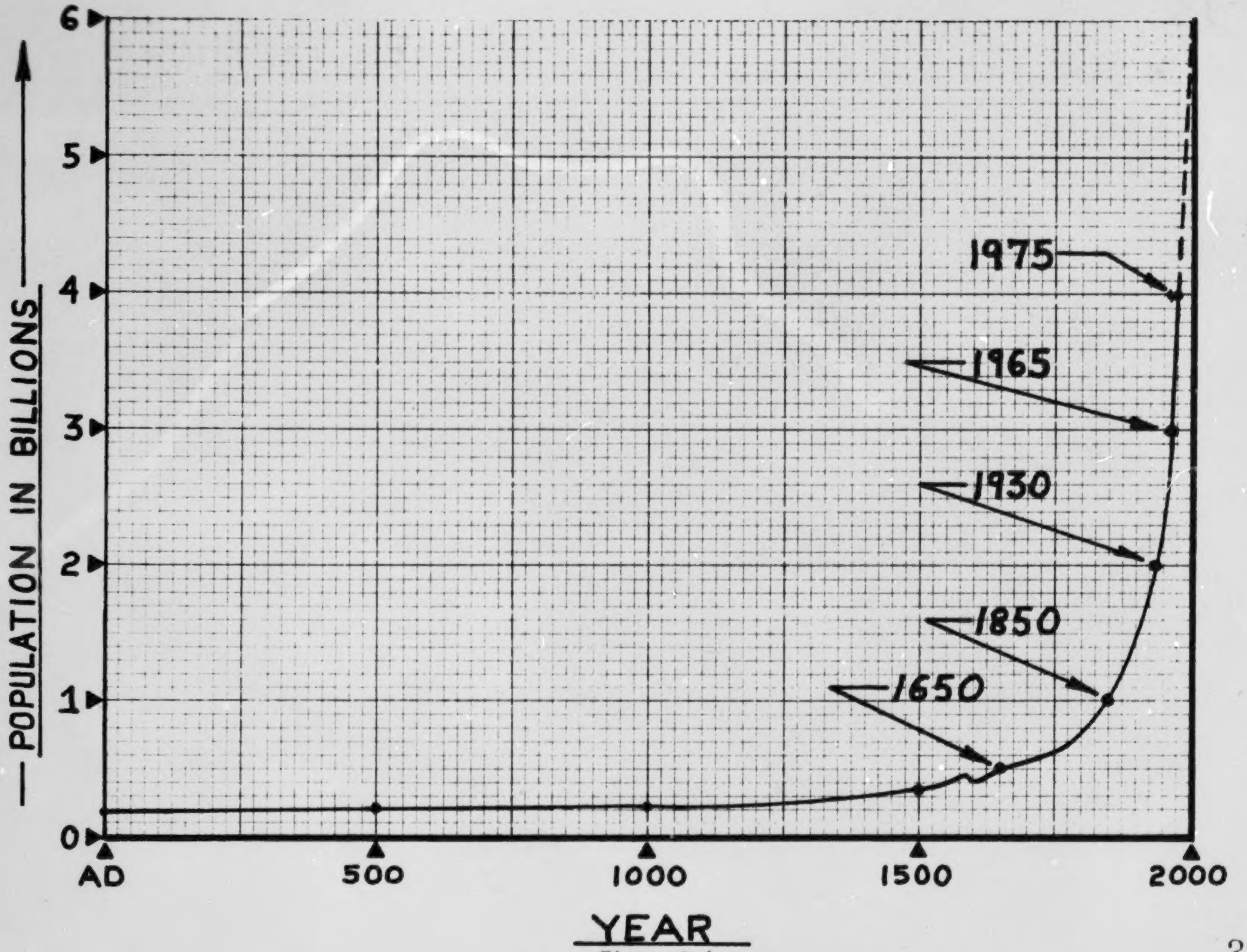

POPULATION IN BILLIONS
6
5
4
3
2
1
0
1975
1965
1930
1850
1650
AD
500
1000
1500
2000
YEAR

Figure I-6

Vocabulary

(Activity I-3)

1. crisis -

2. coal -

3. consumption -

4. energy -

5. fossil -

6. fuel -

7. geothermal -

8. heat -

9. hydroelectric -

10. kinetic energy -

11. light -

12. mechanical energy -

13. natural gas -

14. nonrenewable -

15. nuclear reaction -

15. petroleum (oil) -

17. potential energy -

18. renewable -

19. solar -

20. temperature -

Energy Seek Puzzle

(Activity I-4)

After you have defined the Energy Vocabulary words, you should be ready to try to find them in the puzzle below. When you find a word, put a circle around it and check it off your vocabulary list so you will know when you have found them all. After all the vocabulary words have been found, carefully cross them out. The left-over letters will give you a secret message. See is you can discover how the secret message is written. Write it on another sheet of paper so it will be easier to read.

T	D	E	T	A	E	R	C	R	E	H	T	I	E	N	S	I	F	Y	G	R
H	N	M	[redacted]	R	C	O	A	L	E	H	T	O	N	A	O	T	U	M	R	E
E	O	N	O	N	R	E	N	E	W	A	B	L	E	E	S	U	S	R	O	N
S	R	A	O	H	I	W	[redacted]	E	M	I	T	A	H	G	U	O	I	U	F	E
U	D	T	F	A	S	[redacted]	Y	G	R	E	N	C	E	E	V	R	O	O	E	[redacted]
N	E	U	E	T	I	B	Y	A	R	M	F	I	S	S	I	O	N	D	N	H
I	S	R	N	C	S	O	L	A	R	E	D	N	O	T	P	E	R	N	O	T
S	T	A	E	A	W	E	E	R	U	C	L	A	M	R	E	H	T	O	E	G
T	R	L	F	U	E	L	C	E	S	I	U	H	O	T	L	S	H	A	M	R
H	O	G	R	N	C	W	R	N	E	T	Y	C	E	R	E	N	T	Y	O	A
E	Y	A	G	U	H	Y	D	R	O	E	L	E	C	T	R	I	C	G	R	E
U	E	S	N	Y	I	G	E	E	R	N	G	M	U	E	L	O	R	T	E	P
L	D	A	Y	O	T	R	A	S	L	I	G	H	T	A	H	O	D	R	F	O
T	B	N	H	U	H	E	E	C	I	K	A	N	S	T	S	T	E	E	D	T
I	L	C	A	D	E	N	V	E	S	R	Y	O	N	E	A	C	S	N	E	E
M	I	A	S	O	T	E	O	H	S	E	L	P	R	E	A	C	T	I	O	N
C	O	N	S	U	M	P	T	I	O	N	I	N	H	C	R	E	A	E	T	T
A	U	N	N	O	T	E	X	I	F	S	T	W	I	T	H	O	U	T	R	I
T	T	I	S	C	O	T	E	M	P	E	R	A	T	U	R	E	N	V	E	A
E	S	O	U	R	C	E	O	F	A	L	L	E	N	E	R	G	Y	O	N	L

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide introductory material on energy. It can be used to present an overview, motivate the class, and set the stage for classroom use of one or more of the subsequent chapters.

Only a few activities are included. They have been selected to insure understanding of the basic concepts related to energy consumption and conservation.

Students will need to read and discuss the informational coverage before beginning activities. The vocabulary list may be helpful in fostering comprehension.

The "Day Without Energy" may be used with the entire class or with small groups, perhaps in a competitive setting.

Interpretive questions accompanying the graphs should be used to stimulate class discussion on energy production and population trends.

List of Materials

Activity I-1

instruction and point sheets, either in hand-out ditto form or on transparency, paper or notebook for recording points

Activity I-2

"Energy and Man" slide presentation (no script), slide projector, questions in hand-out form, graphs in hand-out form or on transparencies

Activity I-3

vocabulary sheet in hand-out form and dictionaries

Activity I-4

"Energy Seek Puzzle" in hand-out form and vocabulary list

Activity I-5

"An Introduction to the Energy Crisis" slide presentation and script, slide projector

TEST

1. Which of the following consumes the most energy in the United States?

   * A. electric utilities

   B. coffee pots

   C. steel-mills

   D. farms and ranches

2. The dangerously low supply of natural energy resources is referred to as the ____________________.

   A. National Energy Plan

   B. postwar boom

   * C. energy crisis

   D. China syndrome

3. One-half of the energy consumption in man's history has been in the last 100 years due to

   A. increasing population

   B. inventions

   C. man's demand for a better life

   * D. all of the above

4. List the five sources of American energy which are used most in the United States at the present time.

   oil, natural gas, coal, hydroelectric power, and nuclear power

5. Name two ways that we can overcome the energy crisis.

   (Choice of the following answers: (a) conservation, (b) use of more coal and uranium, or (c) develop new types of fuel)

6. Was wood ever used as a source of energy in the United States?

   Yes or No? __(Yes)__

TRUE-FALSE:

F 7. All energy comes from eating your Wheaties for breakfast.

T 8. Energy is what makes things change or move about.

F 9. Energy has only one form which is electricity.

T 10. Our planet will really have an energy crisis if we don't start doing something about it now.

T 11. Helping to conserve our energy is everybody's job including mine.

F 12. Energy shortages, lack of natural resources and pollution problems are the problems of the President of the United States and not my worry.

F 13. Some energy comes from the sun, some comes from the stars, and the rest comes from the moon.

T 14. Energy cannot be created nor destroyed by ordinary means; it can merely change from one form to another.

F 15. Oil was more valuable 100 years ago than it is today.

Answers: Reading Graphs and Charts

(Activity I-2)

1. wood
2. coal, coal, oil
3. oil, oil
4. environmental concerns - clean air standards
5. nuclear energy
6. 1650 years

   200 years

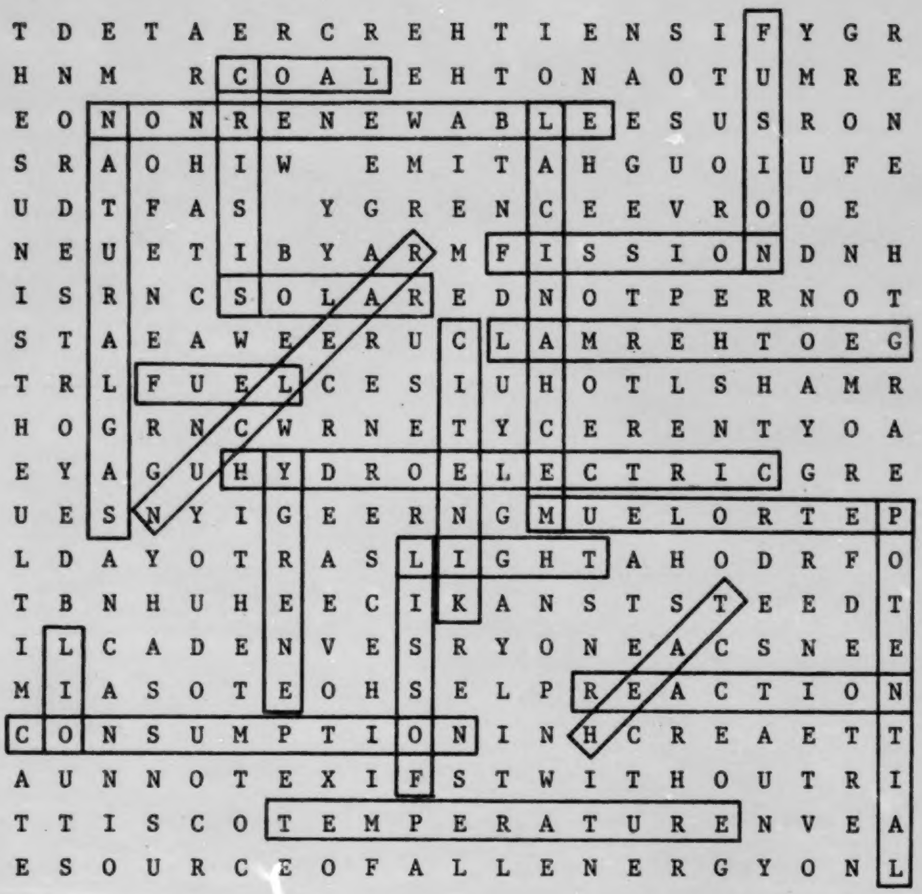
   80 years

   45 years

   25 years
7. It takes slightly more than half the time to double.
8. It approximates a straight, vertical line.
9. About 6 billion

Answers; Energy Seek Puzzle

(Activity I-4)



```
T D E T A E R C R E H T I E N S I F Y G R
H N M   R C O A L E H T O N A O T U M R E
E O N O N R E N E W A B L E E S U S R O N
S R A O H I W   E M I T A H G U O I U F E
U D T F A S   Y G R E N C E E V R O O E
N E U E T I B Y A R M F I S S I O N D N H
I S R N C S O L A R E D N O T P E R N O T
S T A E A W E E R U C L A M R E H T O E G
T R L F U E L C E S I U H O T L S H A M R
H O G R N C W R N E T Y C E R E N T Y O A
E Y A G U H Y D R O E L E C T R I C G R E
U E S N Y I G E E R N G M U E L O R T E P
L D A Y O T R A S L I G H T A H O D R F O
T B N H U H E E C I K A N S T S T E E D T
I L C A D E N V E S R Y O N E A C S N E E
M I A S O T E O H S E L P R E A C T I O N
C O N S U M P T I O N I N H C R E A E T T
A U N N O T E X I F S T W I T H O U T R I
T T I S C O T E M P E R A T U R E N V E A
E S O U R C E O F A L L E N E R G Y O N L
```

Secret Message: The sun is the ultimate source of all energy on earth. Energy is neither created nor destroyed, but is converted from one form to another. Man cannot exist without energy and our use of energy has increased through time. What can you do to help conserve energy? With everyone's help, maybe we can start to decrease our energy use.

An Introduction to the Energy Crisis

(Slide Presentation: Activity I-5)

Slide	Narration
1. ENCORE	
2. Title Slide	Energy Crisis
3. Eskimo with credits	What is energy? On Television "energy" is something we get if we eat certain foods. We need "energy" to make our cars go. We can't see energy, but we can see its effect, we can hear it and we can feel it.
4. Energy is movement	All energy involves some form of movement. Electricity involves the flow of electrons, and radiation is the result of subatomic particles in motion. When we do work of any kind, we are moving some kind of mass and using mechanical energy.
5. Fiddler	Energy comes in many forms. The fiddler's energy creates a sound that's music to our ears while cars, trucks and trains create a roar that's noise to our ears.
6. Energy is chemical	Energy that is chemical is energy produced by building up and breaking down molecules.
7. Flowers	Flowers store energy chemically.
8. Energy is green	The green chlorophyll we see in plants changes the radiation from the sun into molecules that give energy to living things. Our coal and oil comes from plants long buried that once used the sun's radiation.
9. Energy is potential	Potential energy is stored energy.
10. Energy is handy	Energy is handy because liquid fuels from petroleum can be easily transported and stored. Unfortunately petroleum is a non-renewable resource.
11. Energy is free	Nature has provided us with great amounts of free energy but as the sources that are easiest to obtain run out, we are finding that free energy is expensive.

12. Energy is life	Our human bodies are efficient machines that change the fuel we consume into useful work by a process called oxidation. Without this flow of energy from cell to cell we are considered dead instead of alive.
13. Energy is geothermal	Energy can come to us from the earth's interior as geothermal energy. We are only using small amounts of it at present, but drilling more holes might increase the supply.
14. Energy is tidal	As the earth, sun and moon change positions during each day they cause the seas to rise and fall. There are engineers studying ways to use the force of the ocean currents caused by the changing tides. Tidal power plants can generate electrical energy.
15. Energy is convertible	To have the energy we want, when and where we want it, we will have to pay what it costs to convert the natural resources. Some forms are more easily converted than others. Coal and oil when burned, for example, produce electricity.
16. Energy is disappearing	When energy is converted into heat it scatters out in space and disappears.
17. Energy is heat	The sun radiates heat energy.
18. Energy	We like to sunbathe in the sun's warm climate.
19. People	People and plants need the sun in order to grow, and hot days are days for socializing.
20. Distillation	For plant and animal growth the sun distills ocean water to nourish crops and fill rivers.
21. Energy is radiation	According to Greek mythology, a sun god named Helios would drive his chariot through the skies each day so the world would have light. As young people do today when they ask to use the car, his son, Phaeton, asked for permission to drive the chariot and the result was total disaster; when he drove too close,

		the earth would scorch, when he flew too high the earth froze. This is what would happen if energy is uncontrolled.
22.	Black Slide	Without the sun's radiation, we would not have life on earth as we know it, much less the energy to move all the machines that make our work easier and lives more pleasant.
23.	Energy is independent	During this century we have been seeking to become independent from nature's rationing of our basic sources of energy. Independence is the key word. In societies of the past, the good life "called for wealth based on human labor--the many serving the few." A goal worth working for is enough energy for every person. How can we reach this goal? By making the most of our earth's resources.
24.	Resources, the wind	Our world is not running out of all energy sources . . . for example the wind,
25.	"Energy Resources"	but man does need to learn how to change the earth's energy resources into supplies that can be used as the world's population and energy demands grow.
26.	Landscape	Fossil fuel supplies are limited and non-renewable during our lifetime. We must not only become more efficient in converting what remains into usable energy, but develop and make adaptable energy from sources as nuclear fission, wind, geothermal, water and solar. We have an almost unlimited supply of solar radiation, but unfortunately, most of the solar energy is not being used.
27.	Sun	The goals of scientists and technologists at present are to provide us with inexhaustible supplies of energy using our natural resources. The job is not all up to them. We need to make some goals, too.

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Schipper, Lee. Explaining Energy: A Manual of Non-Style for the Energy Outsider Who Wants In. Energy Environment Division. Lawrence Berkeley Laboratory, University of California.

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Woodburn, John H. The Whole Earth Energy Crisis: Our Dwindling Sources of Energy. G. P. Putnam's Sons, 1973.

Zarb, Frank G. "The Seven Truths of Energy." Reprint. Wall Street Journal. September 10, 1975.

Slides and Transparencies

J. Weston Walch, Publisher, Portland, Maine 04104
Slides: "Our Energy Problems," 22 color slides and script.
(energy crisis, where energy comes from, alternatives)

Visual Masters Set: "Energy Resources: Past, Present & Future." Script with introduction, average 1/2 page script per transparency, includes suggested questions. MINIMAL CHARGE FOR SLIDES AND TRANSPARENCIES.

Chart

Energy History of the United States, 1776-1976. ERDA. With "So What's New" user's manual. ERDA Office of Public Affairs, Washington, D.C. 20545.

Films and Filmstrips

Texas Power and Light (Free Loan):
"Energy: Critical Choices Ahead," 27 minutes, color. Graphically analyzes the magnitude of our energy problems.

Kerr-McGee Corporation (Free loan through Modern Talking Pictures)
"The Leading Edge," Future fuel search while intelligently using present resources, #4411.

Edison Electric Institute (Free Loan through Modern Talking Pictures)
"A Question of Balance," 28 minutes, color. Present and future challenges to meet electricity needs.

ERDA Film Library, Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee (Free Loan):
#0507--"Energy--The American Experience" (Past 200 years), 28 1/2 minutes, color.
#0508--"Challenge of the Future" (Looks beyond 2000 A.D.), 29 minutes, color.

National Geographic Society, Department 1037, Washington, D.C. 20036
"This World of Energy," (filmstrips and cassettes) A series of five energy subjects, color, $67.50/set.

ENCORE
Chapter 2

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. name at least five products made from oil.
2. locate, on a Texas map, the areas where major oil and gas fields are located.
3. list chronologically the steps in oil and natural gas production.
4. define a list of vocabulary words related to energy in Texas.

ENERGY IN TEXAS

The Indians were the first to find oil in Texas. When the explorers arrived, the Indians told them the oil had medicinal values. Europeans exploring Texas used crude oil for waterproofing boats in 1543 in the DeSoto expedition near Sabine Pass.

The first drilled well to produce oil in Texas was at Melrose, in Nacogdoches County. To reach the oil, the driller, Lyne T. Barret, used an auger which he fastened to a pipe. The pipe was rotated by a steam engine-driven cogwheel. His basic technique of rotary drilling is still used today in large modern rigs.

In 1867, wells began to produce oil throughout Nacogdoches County. Later, Nacogdoches County became the site of the first commercial oil field in Texas.

It was not until the year 1894 that Texas had a major oil discovery. A water well being drilled for the city of Corsicana brought in oil instead of water and the well as abandoned. Then, in 1895, a company went in and drilled several oil-producing wells, and later built the state's first well-equipped refinery.

The most famous date in Texas petroleum history is January 10, 1901, when oil gushed from "Spindletop" near Beaumont. This was the first salt dome oil discovery. It was this well that encouraged the exploration and drilling in Texas that has continued since that time.

The East Texas oil field, the biggest of them all, was discovered near Turnertown and Joinerville, Rusk County in 1930. This discovery was followed by the biggest leasing campaign in history. The field was extended from Rusk County to Kilgore, Longview and northward.

The most important oil discoveries made since that time have been in West Texas in Scurry County, the major one being in 1948, which brought about later developments in that area.

Oil production is one of the major industries in Texas. Production includes exploring for and finding an oil deposit, drilling, transporting, refining, and distributing.

Finding oil is a "scientific process"; not the hit-and-miss ordeal that it was in the 1800's. There are several ways that scientists and geologists try to find oil. One way is to make seismic studies. A controlled explosion sends shock waves into the ground. The scientists record the deflected waves on a seismograph. The seismograph maps where the soft and hard rock formations are. Certain rock formations are likely to contain oil. These can be identified on the seismograph.

Another method of finding oil is to measure the magnetic force of an area. Iron rocks are more magnetic, so with the help of a magnetometer (a large compass) geologists map the iron rock formations. From this information, more specific explorations can be made to determine which formations contain oil.

A third method of finding oil is by measuring the force of gravity which varies from place to place depending on the type of rock underneath. With the help of a gravimeter, the geologists can map the rock formations; and this information can tell the most probable location of trapped oil. Even with all these sophisticated methods, only one out of every nine wells drilled produces oil!

Once the oil men decide on the location, where they hope to find oil deposits, the drilling begins. Roads are built to the site, supplies are brought in, and a rig is set up. Rigs resemble big windmills without blades and they are reusable (Figure II-1). The drill pipe stands in the middle of the rig and extra pipe is nearby for use when the drilling gets deeper. Blow-out preventers are located underneath the rig floor; their purpose is to prevent drill pipe from being blown out of the hole in case of unexpected high pressures. A bit is attached to the bottom of the drill stem. Its hard toothed wheels cut the earth and rock as the stem turns. The drill starts, mud is pumped down the stem, out the bit, and up the sides of the hole. The mud acts like a cork if high pressures are encountered. The mud controls the pressure and prevents an explosion. It also carries away cuttings and lubricates the bit. The average depth of wells in the U.S. is about 4,300 feet, but some wells are 10,000 feet or 25,000 feet deep! The deepest well in the world is 6 miles deep and cost 6 million dollars to drill. If oil is found, production casing is cemented on the well and a system of valves and pipes--called a "Christmas tree"--regulates the flow of oil on the surface. The rig is taken away to be used again.

This new-found oil flows into storage tanks near the wells. From there, it can be carried by truck, tankers, train, barge, and most commonly by pipeline, to the refinery.

At the refinery, the crude oil is made into many different products: kerosene, gasoline, diesel fuel, grease, motor oil, asphalt, and bottled gas (Figure II-2). The refineries boil the crude oil. At 100°, the lighter products vaporize; at 200° the medium products vaporize, and so on. The vapors condense just below their boiling points. Therefore, if a vapor condenses at 200°, the condensate is a medium product. If the vapor is condensed at 100°, a light product is formed such as jet fuel or kerosene.

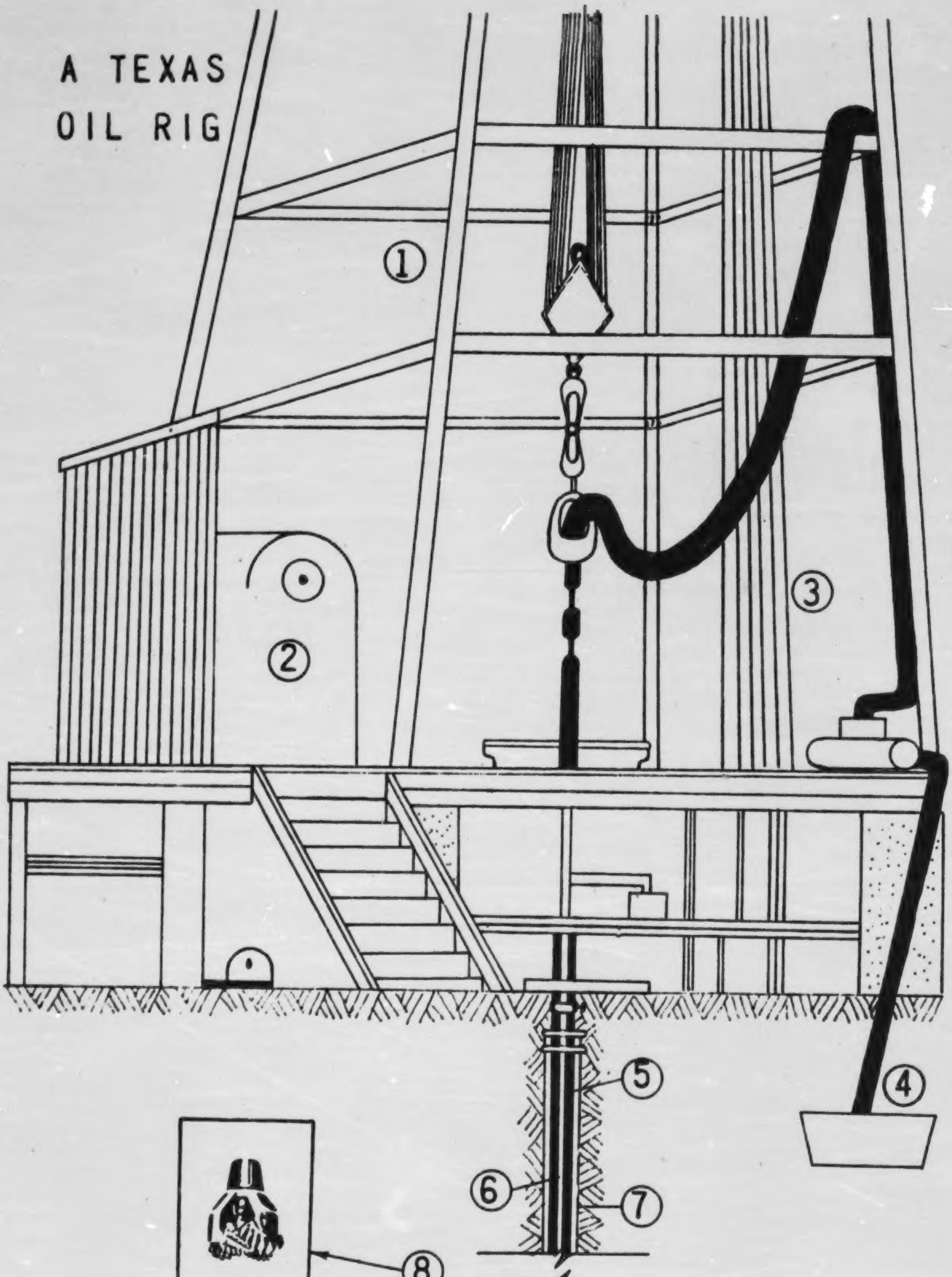

A TEXAS
OIL RIG
①
②
③
④
⑤
⑥
⑦
⑧

Figure II - 1

Legend for Figure II-1

1. The steel derrick of a big rig is 15 stories high. It handles the drill pipe and tools.
2. Engines provide power for raising and lowering the pipe, and rotating it in the hole.
3. Drill pipe not in use, stands inside the derrick. Oil men call a section of pipe a "joint".
4. Drilling mud is pumped down, brings up cuttings, is filtered, and then used again.
5. Mud cools the drill bit, flushes out cuttings, and controls underground pressure.
6. Pipe in the hole is the "stem". It may be handled in "stands" of three joints each.
7. Another pipe, bigger than the drill stem, is the casing. It keeps the hole from caving in.
8. The business end of the drill stem is the bit. Its hard-toothed wheels cut the earth as the stem turns.

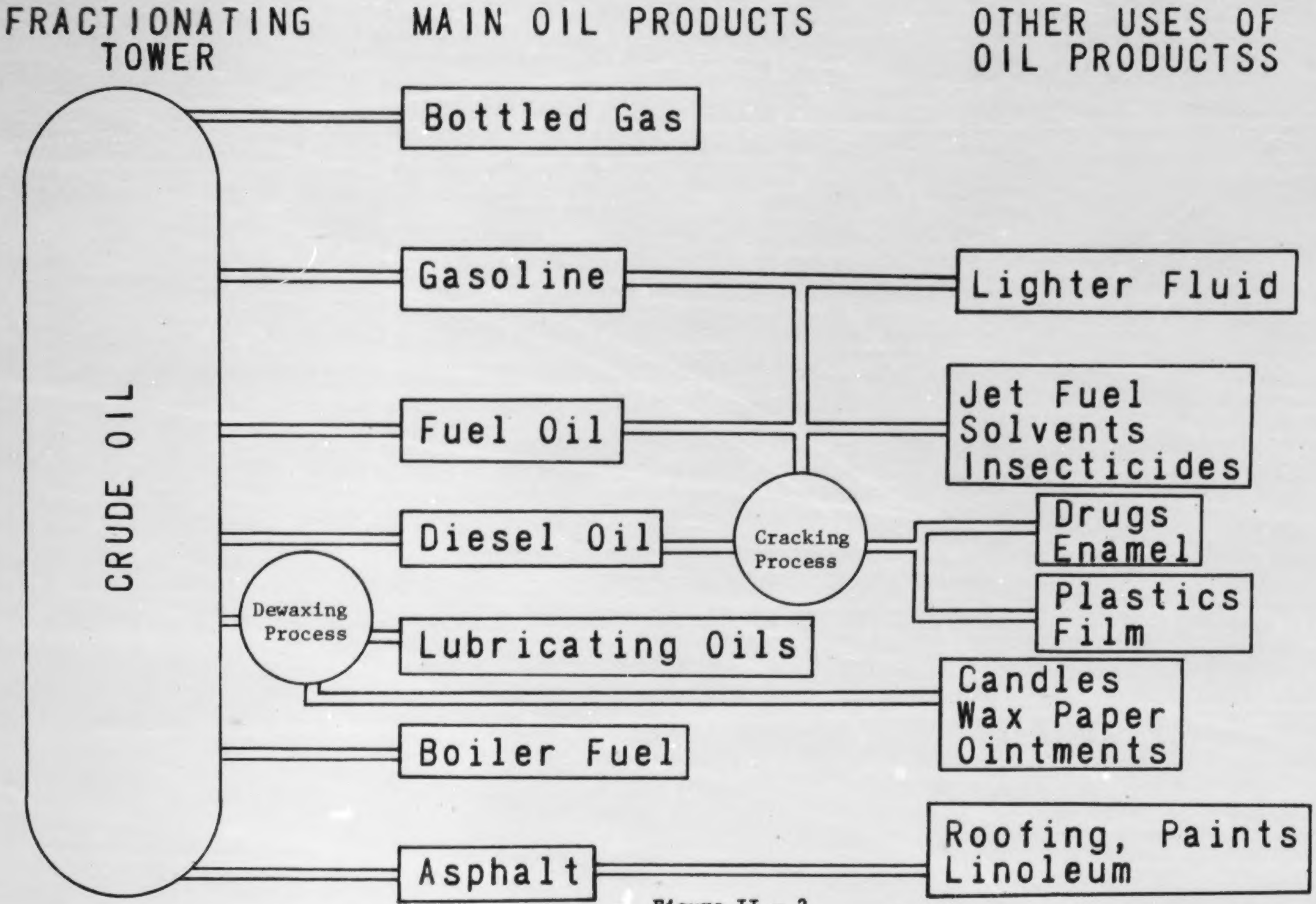

FRACTIONATING TOWER
MAIN OIL PRODUCTS
OTHER USES OF OIL PRODUCTSS
CRUDE OIL
Bottled Gas
Gasoline
Fuel Oil
Diesel Oil
Lubricating Oils
Boiler Fuel
Asphalt
Dewaxing Process
Cracking Process
Lighter Fluid
Jet Fuel
Solvents
Insecticides
Drugs
Enamel
Plastics
Film
Candles
Wax Paper
Ointments
Roofing, Paints
Linoleum

Figure II - 2

These different products are refined further to remove unwanted wax, asphalt, resin and tar. Additives are used to develop the desired characteristics. Then the oil is distributed by tanker, train, barge, truck or pipeline to the consumer, or to a terminal where oil is stored before selling it to retailers.

Natural Gas in Texas

Natural gas is a temporary energy source. Like oil, it is a fossil fuel. Through millions of years of pressure on organic material, it is formed as a mixture of gaseous hydrocarbons, made up mostly of methane. Through combustion, it releases its stored chemical energy.

Natural gas is a plentiful resource in Texas. It is used as a fuel for space heating, for cooling and for electric power generation. It is produced in much the same manner as oil. Once it has been found and a pipeline has been laid, the gas goes to a processing plant (sometimes referred to as a scrubber). The scrubber takes any liquid out of the gas (drip or natural gasoline) and removes other impurities such as hydrogen sulfide and carbon dioxide. The hydrogen sulfide can be used to manufacture sulfuric acid, fertilizers, and paper. Propane, butane, and ethane are also separated from natural gas (methane). The clean natural gas can be stored underground in old, empty wells, or it can be compressed for storage. Natural gas can be compressed from 630 cubic feet to one cubic foot of liquified petroleum (LPG). Because of the liquification process, large tankers can carry natural gas to needy countries.

The natural gas flows from the processing plant through a pumping station which boosts the pressure of the gas to keep it flowing through the long pipes. From the pumping station, the gas flows to the regulator station which is located in the community. The regulator station reduces the pressure of the gas so it can be used in household appliances, and it also meters the amount of gas used by the community. From the regulator station, the natural gas flows to the houses and industries for instant, convenient use.

Today, the basic mineral fuels, crude petroleum and natural gas, along with their associated products permeate the economy of Texas more than any other activity.

Electricity in Texas

The word electricity comes to us from the word "elektron," meaning amber.

In the 18th century in Europe and America, possibilities for electricity came into focus through Benjamin Franklin who made several discoveries about electricity. His most famous discovery came from his experiment of flying a kite in a thunderstorm. He proved that lightning is a natural form of electricity.

The use of electricity did not become practical until Thomas Alva Edison invented the incandescent lamp, the light bulb. Some of Edison's other inventions were the electric railway and the modern storage battery. He built the world's first electric power plant in New York City, and made electric lighting a reality rather than just a dream.

In the beginning electricity could be sent only short distances. By the 1920's high-voltage lines were carrying electric current for distances of more than 200 miles and electricity began to be used throughout our country. The electricity was produced by small hydroelectric and coal-fired plants.

The location of the first power plant in Texas is uncertain. Some believe Galveston was the first. Others believe the first was put into operation on December 17, 1882, in Houston. At any rate, either of these would be among the first in the United States.

In 1912 Texas Power and Light Company started building Texas' first high-voltage transmission line. It extended from Waco to Fort Worth, with a branch from Hillsboro through Waxahachie to Ferris; then it went north to Trinity Heights (Dallas) and south to Corsicana. Rural electricification came about in Texas during the 1930's.

In Texas today there are 178 power plants; 91 of which are powered by steam, 66 are powered by internal combustion engines, 21 are hydroelectric plants, and 7 purposed nuclear powered steam plants. The sites for the purposed nuclear power plants are: Glen Rose, Texas (2), Jasper, Texas (1), Wallis, Texas (2), and Bay City, Texas (2).

ACTIVITIES

1. Make a model, poster, or bulletin board of an oil rig and all of its parts; refer to Figure II-1 (Activity II-1).

2. On the Texas map, shade in with watercolor, crayola, or magic marker where the major oil and gas fields are located. Is your town on top of an oil or gas field (Activity II-2)?

3. On three separate pie charts, show these ratios:

   A. More than 25% of the oil wells in the U.S. are drilled in Texas.

   B. One-third of the oil and gas in the U.S. is produced in Texas.

   C. More than 1 out of every 4 gallons of major U.S. oil products are made in Texas refineries.

   Label your pie graphs and label the "pieces" of the pie (Activity II-3).

4. Define vocabulary words (Activity II-4).

   compress -

   condensate -

   condense -

   crude oil -

   gravimeter -

   liquified petroleum (LPG) -

   magnetometer -

   refinery -

   seismograph -

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide an overview of the two major energy sources of Texas--oil and natural gas. There is also information on electricity production in Texas. This information can be used to motivate or inform the class of Texas' vital position in the overall U.S. energy supply.

The four activities have been selected to insure understanding of the basic concepts related to energy in Texas, not necessarily the energy-producing industries themselves.

Students will need to read and discuss the informational coverage before beginning activities. The vocabulary list may be helpful in fostering comprehension.

Constructing a model or bulletin board of an oil rig can be done by the class or small groups. A mural showing the rest of the petroleum industry (from drilling through refinement to distribution and commercial use) would be beneficial.

The pie graphs are used to show how important Texas is in U.S. oil production.

Locating the oil and gas fields in Texas brings the study of Texas energy closer to home. Suggest to your students that they find relatives' home towns as well as their own town or towns like Beaumont and Corsicana where historical events in the oil industry took place.

List of Materials

Activity II-1

- cardboard
- posterboard
- pipecleaner
- construction paper
- Figure II-1 (as a guide)
- clay
- paper mache
- tape
- glue, or any medium suitable for constructing an oil rig

Activity II-2

- Texas road map
- watercolors, crayolas, or magic markers

Activity II-3

- compass
- protractor
- paper

Activity II-4

- vocabulary list in hand-out, ditto form

TEST

1. Name five products made from crude oil. (Refer to Figure II-2)

2. The word electricity means ___(amber)___.

3. A method of finding oil in the earth is with a

   A. gravimeter

   B. seismograph

   C. magnetometer

   * D. all of the above

4. To reach the oil in the earth,

   A. miners dig tunnels

   B. engineers blow a hole in the earth and let the oil run out

   * C. engineers drill a hole and regulate the flow of oil with a "christmas tree"

   D. Jed Clampett goes hunting for food.

5. Crude oil is made into many different products at the

   * A. refinery

   B. brewery

   C. gas station

   D. power plant

6. "Scrubbers" are used

   A. on oil rigs

   B. on factory roofs

   * C. in the production of natural gas

   D. in the production of uranium

7. Oil and natural gas are transported in

A. baskets

B. sacks

C. box cars

* D. pipelines

8. Natural gas can be compressed from 630 cubic feet to ____________ cubic feet (foot) of liquified petroleum.

* A. one

B. ten

C. 63

D. 629

9. Two people who made scientific discoveries about electricity are

A. Richard Nixon and Henry Kissinger

* B. Ben Franklin and Thomas Edison

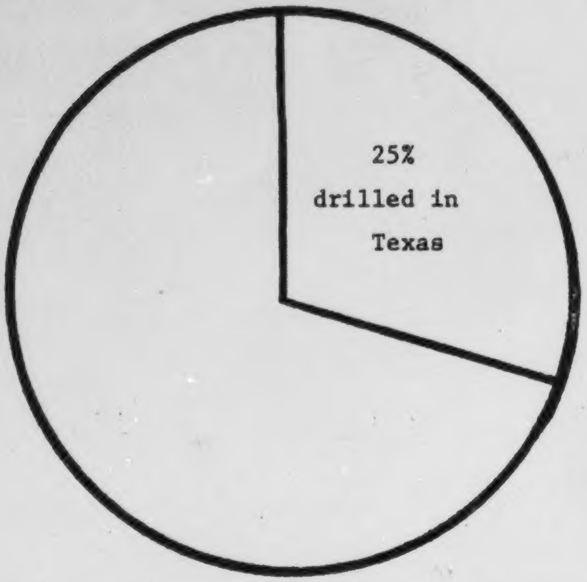
C. your librarian and principal

D. George Washington Carver and Dr. Salk

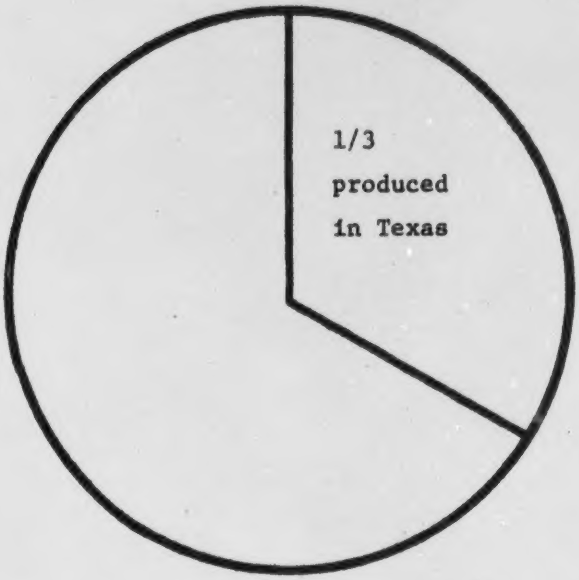
10. Does Texas play a very important role in total U.S. oil production?

Yes or No? (Yes)

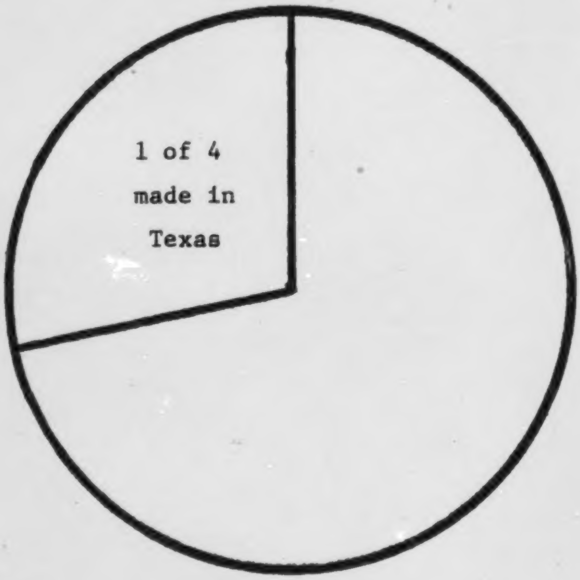
Answers: Activity II-3



Oil Wells in U.S.

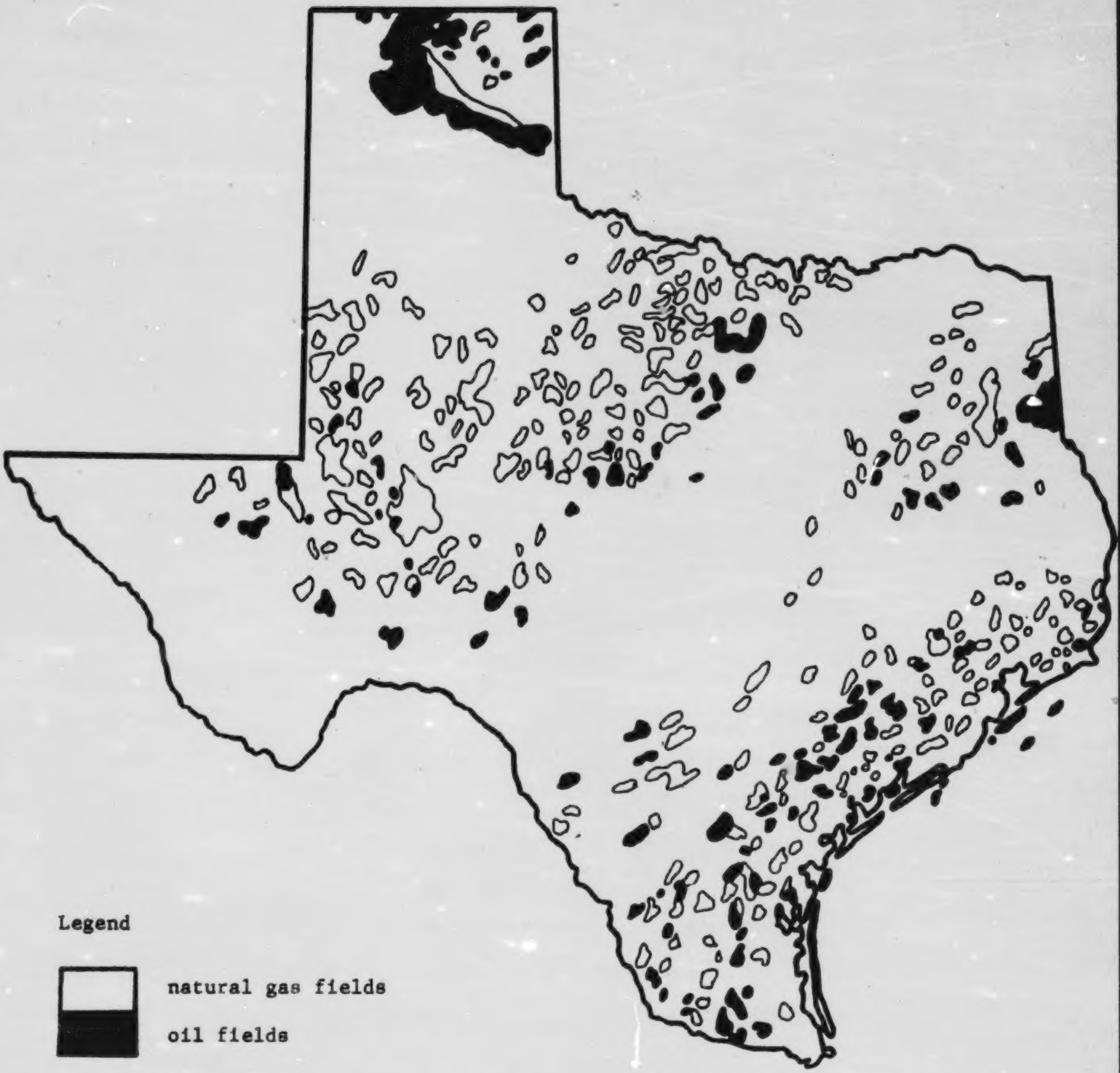


Oil and gas in U.S.



Major U.S. oil products
(gallons)

Answers: Activity II-2


Legend
natural gas fields
oil fields

RESOURCE LIST

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Small Homes Council-Building Research Council, Living with the Energy Crisis, University of Illinois, 1973, Champaign, Illinois, 61820

Texas Energy Report No. 1, Austin, Office of the Governor Division of Planning Coordination, 1974.

The Energy Institute, University of Houston, Houston, Texas, Texas Energy, Library of Congress Catalog Card No. 74-17363.

Films

Energy from the Artic, Michigan Consolidated Gas Company, One Woodward Avenue, Detroit, Michigan 48226. 30 minutes, color, free loan. Alaskan pipeline and environmental effects.

No Short Cuts, Interstate Oil Compact Commission, P. O. Box 53127, Oklahoma City, Oklahoma 73105. 25 minutes, color, free loan. Oil location and petroleum industry overview, advanced level.

Fossil Story #12001, Shell Film Library, 1433 Sadlier Circle West Drive, Indianapolis, Indiana 46239. 15 minutes, color, free loan. Development of fossil fuels from prehistoric plants.

Quest, Modern Talking Picture Service, 4084 Westheimer Road, Houston, Texas 77027. 27 minutes, color, free-loan. Oil exploration by petroleum company.

This World of Energy, National Geographic Society, Department 1037, Washington, D.C. 20036. A series of five energy subjects (filmstrips and cassettes), color, $67.50/set.

ENCORE

Chapter 3

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. pick coal samples from samples of other earth materials.
2. make a list of the various ways coal is mined.
3. match the type of deposit with the method of mining used.
4. name orally, or list in writing, at least ten products obtainable from coal.
5. define a list of vocabulary words related to coal.

COAL

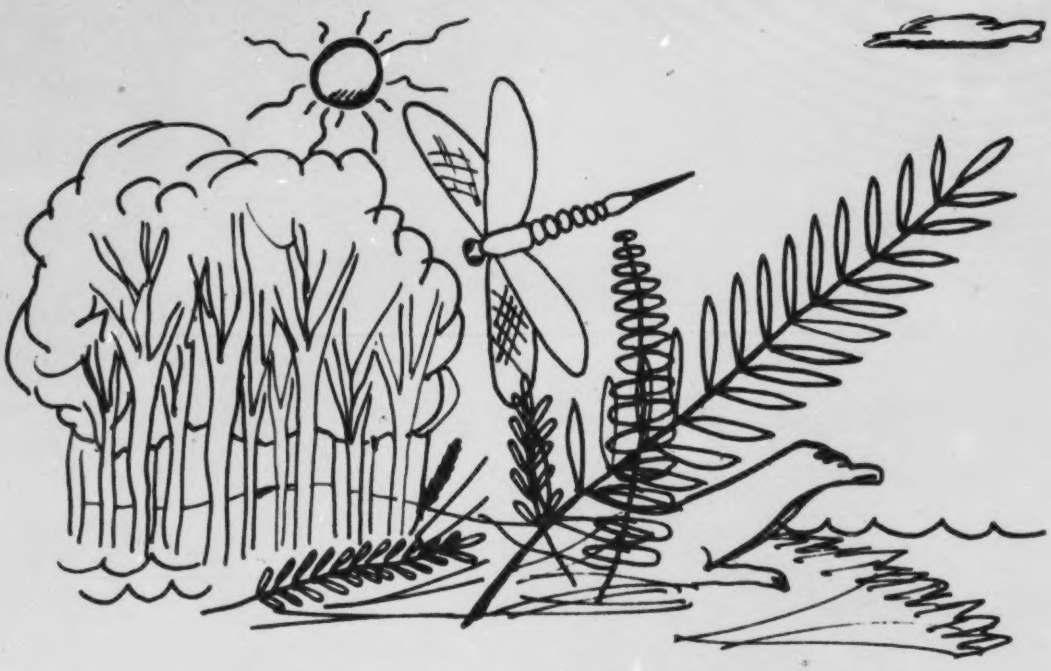
Coal, a soft black or brown rock, is probably the most useful rock ever mined. Coal can be burned to produce heat directly for homes and offices. Coal can also be burned to boil water and produce steam for electrical energy production. The steel industry bakes coal to form coke which is used in blast furnaces. Coal also supplies us with many useful chemical products.

Coal, iron ore and petroleum have helped make the U.S. an industrial giant. The U.S.S.R. is the only country that produces more coal than the U.S..

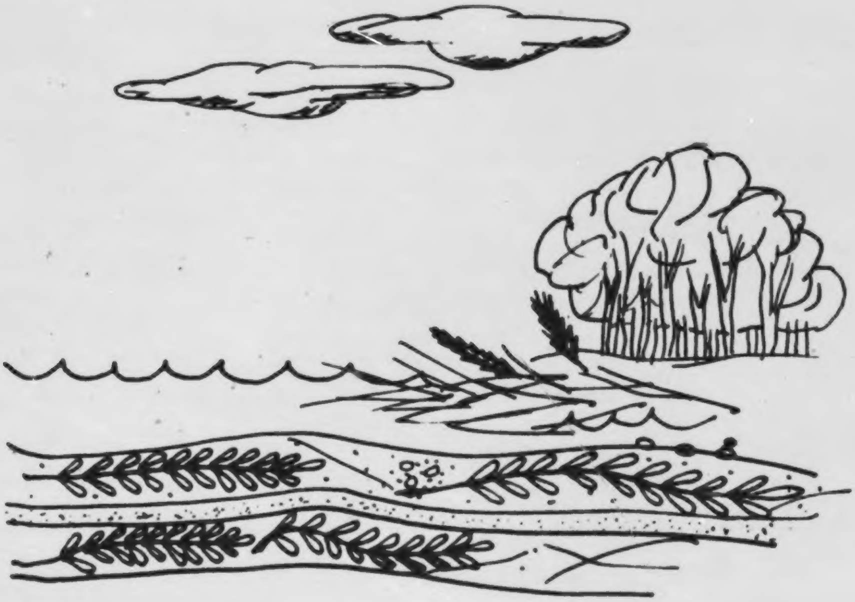
Coal provides a large percentage of power and heat for industrial nations. In the U.S., coal supplies approximately one-fifth of all its power and heat.

Just how was coal formed? A brief pictoral description is given in Figure III-1.

Peat is the first stage of coal formation. Some classify it as a fossil fuel or as "geologically young coal." It is essentially an accumulation of plant remains in varying stages of decomposition. Peat is usually formed in areas where water saturates or covers dead vegetation that has accumulated on the ground. The water blocks the action of aerobic bacteria, thus greatly slowing the rate of decay of plant debris. Most of the carbon is retained, and peat is formed. If the plant matter were exposed to the aerobic bacteria, decomposition would occur without the formation of peat. The type of peat found in Minnesota is typically about 100 years old near the surface and up to 10,000 or more years old at the lower boundaries of the deposits, which average an estimated 6 to 20 feet in depth.

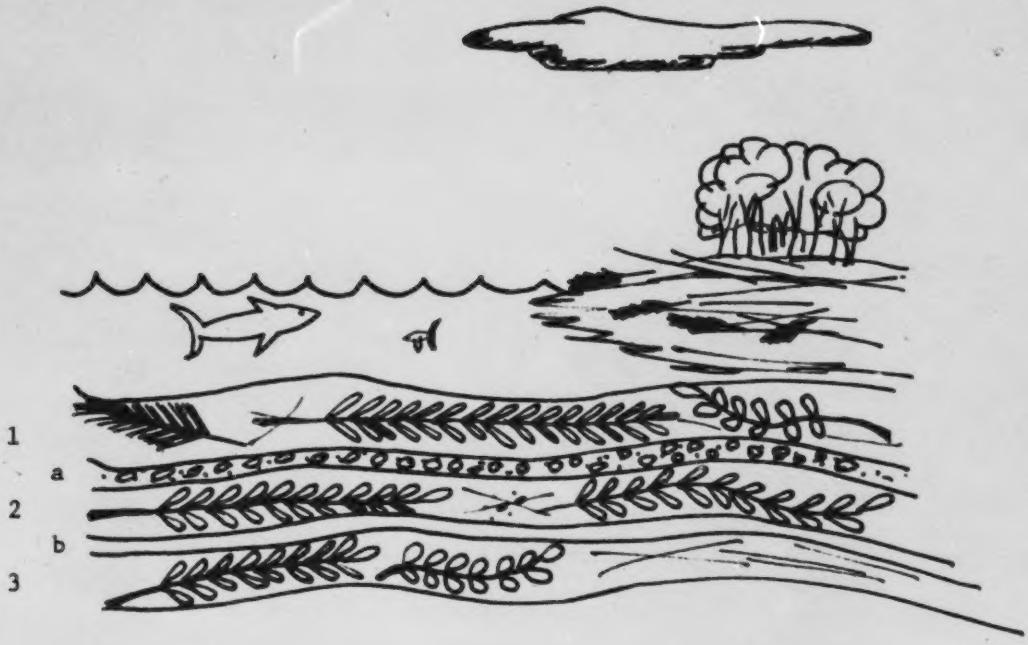


1. Dense forests and swamps covered much of the earth's surface hundreds of millions of years ago. They were filled with strange-looking trees, giant rushes, and wide-spreading ferns. Among the plants lived big lizards and giant insects.

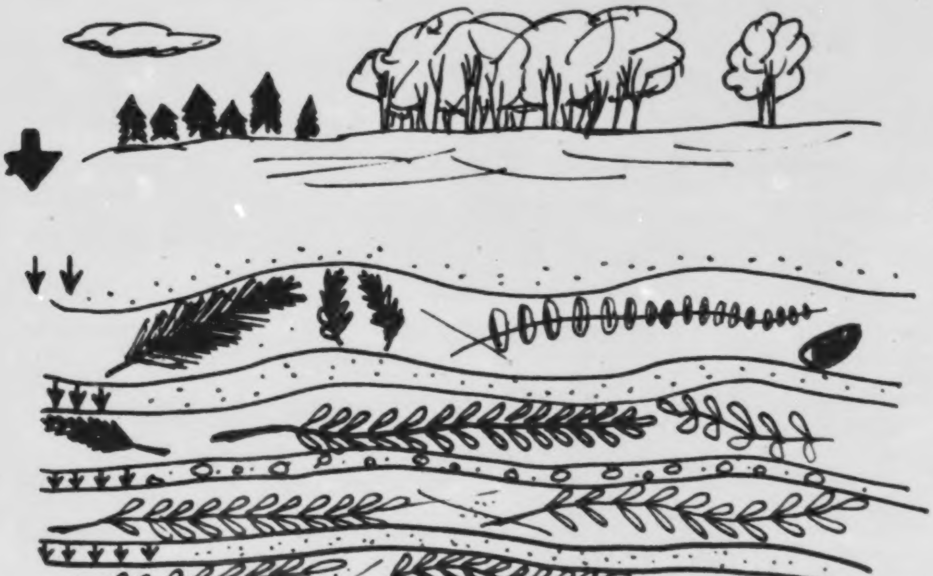


2. As the giant plants died, they fell into the swamps. The dead trees and ferns became tangled in a mass of decayed vegetable matter. This spongy, brown vegetable matter is called peat, the first material in the formation of coal.

Figure III - IA



3. New plants grew on top of the old. Then they, too, died and became part of the mass of peat. Water sometimes covered the area. Different thicknesses (1, 2, 3) were caused by dirt and sand (a,b) being deposited between layers of peat.



4. Heat and pressure caused different types of coal to be formed. Where the heat and pressure were greatest, usually as the result of folding of the earth's crust, the soft coal (bituminous) was formed into the hardest rank of coal (anthracite).

Figure III - IB

Peat has a certain advantage and disadvantage as a fuel. It is relatively easy to "mine" or "harvest," since it is located on or near the surface. It is low in sulfur content and, therefore, poses less of a pollution problem than many fossil fuels, and it has considerable heating value. The heating value of air-dried peat is superior to that of wood, about equal to that of lignite, and about half that of anthracite. Among its disadvantages, peat contains 70 to 95 percent water, which must be reduced considerably before it is burned. It is generally located in remote areas, some distance from major users. It is bulky and costly to transport.

Lignite

Lignite, a brownish-black coal gives off more heat than peat does when it is burned. Lignite, however, still is a low quality coal. It is found mostly in the states of North Dakota, South Dakota, Montana and Texas. The Texas lignite is found primarily in the eastern segment of the state (see Figure III-2).

Lignite represents an early stage in coal formation. Most lignite is soft and crumbly, has a low specific gravity, a high moisture content, is porous, and contains pieces of plant material. Lignite was one of the first resources used by early settlers in Texas. There are reports of a mine in East Texas as early as 1819 and of exposed layers of lignite on the banks of the Trinity River in 1839. Most of the mines were underground operations with hauling done by mules. Later gasoline-operated locomotives and steam-operated slope engines were used. Cave-ins and water flooding presented serious problems.

Lignite was mined at various places in East Texas before the large scale use of natural gas for home and industry. Before 1950 most mining

Coal Deposits in Texas

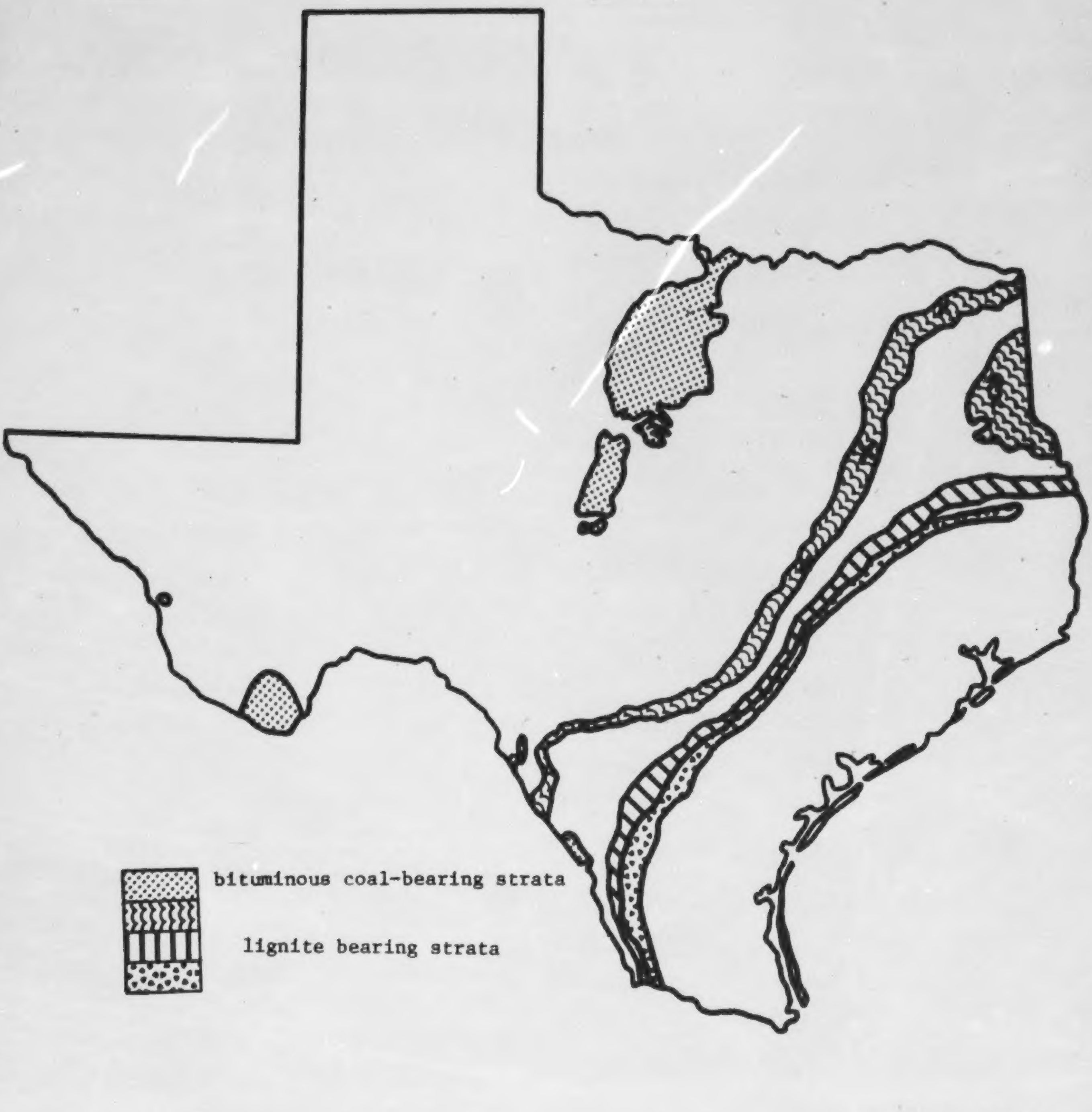

bituminous coal-bearing strata
lignite bearing strata

Figure III - 2

was underground. Since 1950 open pit mining has generally been used.

Besides its use as a fuel, lignite may be used as a source of chemical products. Such products as benzene, napthalene, crude creosote, road tar and bituminous coatings are manufactured from lignite. Activated carbon, used in water treatment and recovery of gold, is produced from Texas lignite by the Darco Plant of Imperical Chemical Co., Ltd. near Marshall, Texas.

Lignite is a bulky material and contains relatively small amounts of energy per pound. Only those deposits close to a market have been used. Now, lignite located less than 200 feet below the surface is being used and deeper deposits are not considered practical for open-pit mining.

Many lignite deposits are at a depth of 200 feet or more below the earth's surface in Texas. Research is being conducted to find practical means to change it to a gas at its natural location below the surface of the earth. Other projects are investigating liquifying coal and pumping it to the surface. This method will produce no unsightly damage to the land's surface. Most of these projects will be ready for field testing in the near future.

Bituminous

Bituminous coal is harder than lignite, but still called "soft coal." The percentage of carbon in bituminous coal is usually 75 to 85%. Bituminous is our most abundant kind of coal. It is the chief fuel used in coal-burning electrical power plants. A major source of biuminous coal is the eastern half of the U.S.. Large deposits have been found in Utah, Colorado and Montana, but due to the location of the major coal users--the eastern steel industry--transportation costs have made coal extraction from Utah, Colorado and Montana unprofitable.

Anthracite

Anthracite, "hard coal", has a shiny black color and burns without smoke. Compared to soft coal, there is very little hard coal in the United States. Anthracite's carbon content may be as much as 95%. Most of our anthracite is found in Pennsylvania.

Although time is important in determining the degree of carbonization, it is not the only factor. Compression and thermal conditions may be more important. Coal of the same age may be of different grades in different localities. For example, from the sub-bituminous area of Iowa eastward to the anthracite region of eastern Pennsylvania, coal of the same age increases in the degree of carbonization. Still further east, in Rhode Island, completely carbonized material of the same age is found in the form of graphite. Clearly, the degree and nature of the disturbance of the earth's crust are closely related to the degree of carbonization of the organic material.

The Pennsylvanian Period is called the Great Coal Age. Although the Pennsylvanian Period was the great coal-forming age, coal is found in the rocks of the preceding (Mississippian) period and in the rocks of more recent periods. The rocks older than the Mississippian are not known to contain productive coal beds. Therefore, the geologist or prospector in search of coal deposits would confine himself to regions where the rocks are Mississippian age or younger. Furthermore, he would confine his search to those rocks that are nonmarine in origin.

Aside from wood and charcoal, coal was our most important fuel for many years. It is still important in the production of steel from iron ore and electric power generation. In fact, one-fourth of the coal produced every year is used as coke for the steel industry. The other three-fourths is used in heating and chemical by-products (see Figure III-3).

The coke is burned in blast furnaces, where it supplies carbon. The carbon combines with the oxygen in the iron ore to make oxygen-free iron. In the future, coal may become even more valuable as coke than as a heat source.

Coal can also be converted into oil and gas for use in automobiles, trucks, buses, and furnaces. Coal gasification is still in the experimental stage, but it may become our primary supplier of gas if our oil and natural gas supplies continue to decline.

Now, coal supplies about 18% of the U.S. energy demand. The percentage has been declining since the mid 1900's. More convenient, cleaner, and until recently, cheaper oil and gas have replaced coal as primary fuel sources in the United States.

No one really knows how much coal there is. One recent estimate is that we have three trillion tons of coal. This includes discovered, undiscovered, economic and subeconomic deposits of coal. If one speculates that perhaps 20% may be recovered economically then at the current production rate, 600 million tons per year, a 1000 year supply exists. Substituting coal for 93% of the total U.S. demand, three trillion tons of coal would last about 200 years. If the U.S. demand for energy continues to increase at historic rates (3.9% per year) the coal would last about 60 years.

Coal is more plentiful than oil and gas, but it is neither a substitute for energy conservation, nor is it a long-term source of energy.

Coal can be mined by two methods: surface mining and underground mining. Surface mining, also called strip mining, is used when the coal seams are close to the surface. Huge power shovels remove the overburden to get at the coal steam. The coal is then removed and the overburden replaced.

PRODUCTS OBTAINED FROM COAL BY CARBONIZATION

LIGHT OIL 1.5%
dyes
medicine
perfume
varnish
synthetic rubber
plastics

CHEMICALS .5%
nitric acid
ammonia
pyridine

GAS 17%
insecticide
lighting
fuel
heating
gold and silver plating
pigment

TAR 5%
pipe covering
roofing
wood preservative
lubricant
fuel
disinfectants
insulation

COKE and COKE BREEZE 76%
fuel
pencil lead
baking powder
smelting
briquets

Figure III - 3

Underground mining is used when the coal seam is deep in the ground. There are three types of underground mining: shaft, drift and slope mines (see Figure III-4). Shaft mines reach deep deposits of coal. A shaft is dug and then the miners dig the coal out of its horizontal seams. Drift mines are used to reach coal beds in hillsides. Slope mines are also used to mine coal beds in hilly areas. Most of the coal produced in this country comes from underground mines even though strip mining is faster and more efficient.

As seen in Figure III-3, coal can be made into an enormous number of products. In the years to come, scientists and chemists will undoubtedly increase this list many times.

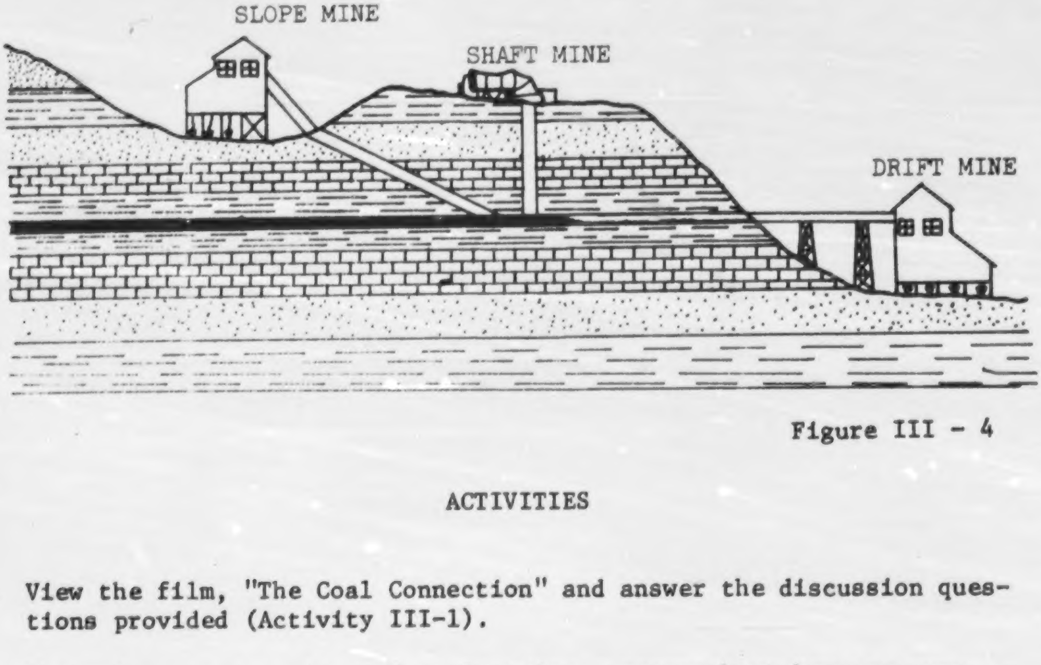


Figure III - 4

ACTIVITIES

1. View the film, "The Coal Connection" and answer the discussion questions provided (Activity III-1).

2. Pretend you are a piece of coal; write a story about how you were formed. Include your initial environment and the changes you went through. You can get your information from this chapter, an encyclopedia, or any resource book (Activity III-2).

3. Set up a panel debate. Pick two or three people to debate for deep-mining and two or three people to debate for strip-mining. Research encyclopedias, the subject catalog in your library, or per-

haps your science teacher can help. Be able to defend your side of the debate question. Elect a timer. Each person gets two minutes to talk. One person on one side and then one person on the other side speaks. Then the second person on the first side speaks and the second person on the second side speaks. Ask your drama or speech teacher for tips on how to debate. Be civilized and have fun Activity III-3).

4. On a Texas map shade in with water color, crayolas, or magic marker where the major coal deposits are located. Is your town on top of a coal deposit? (Activity III-4).

5. Make a facsimile of a fossil. Grease a 6 X 9 inch pan. Mix plaster of paris in a separate container until it is about the consistency of putty. Then pour into the greased pan. Press a good-sized leaf into the surface of the plaster. As soon as the imprint is clear, remove the leaf gently and let the imprint dry. Make several different fossils using different types of leaves. Paint the dried plaster with black, water-based paint and display as coal fossils from the Carboniferous era (Activity III-5).

6. Examine lignite and coal samples under a microscope. From the coal samples, find a sample of peat, lignite, bituminous and anthracite and arrange according to their hardness. Take a piece of coal and scratch it, taste it, and with the teacher's help, burn it in a bar-be-que pit and have a hot dog roast (Activity III-6).

7. Define vocabulary words (Activity III-7).

Discussion Questions

(Activity III-1)

On a separate sheet of paper, answer the following questions, based on the film "The Coal Connection."

1. How do you think electricity is produced for our town? Why would this method be preferred over the others shown?

2. Why do you think there are so few nuclear power plants in the U.S.?

3. Why do you think a town would prefer not to use oil or coal as fuels for steam-powered generators?

4. What do you think would be some of the henefits of using hydro-electric electrical production over the usual fossil fuel forms of production?

5. How long do you think our coal reserves will last, based on our current rate of consumption?

Vocabulary

(Activity III-7)

1. anthracite -

2. bituminous coal -

3. black lung disease -

4. carbonization -

5. coal gasification -

6. coke -

7. iron ore -

8. lignite -

9. peat -

10. strip mining -

11. surface mining -

12. underground mining -

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide information on coal, its formation and uses. The four different types of coal and a brief description of the three different methods of mining are also included.

Seven activities are included for the students. The discussion questions enable the students to think about their own environment. Activities III-2 and III-3 require research, but they can be very interesting if the teacher provides the proper setting and instructions. Activity III-4 can be done with the same Texas map that was used in Chapter II (it will also be used in later chapters--be sure to save it!). Activity III-5 is more of a crafts or arts activity--be sure to display the results. For Activity III-6 let the students study coal samples by themselves and write a list of coal characteristics on the board. The vocabulary list may be helpful in fostering comprehension.

Students might also be interested in writing individual reports related to coal. Completion of all activities is not necessary. Do those activities which emphasize topics that you want emphasized, or those which seem most interesting to the students. A field trip to a coal power plant or mining site would be great. Perhaps students can collect articles, interview teachers, or even take a poll of their neighborhood concerning controversial mining methods. The more involvement, the better.

List of Materials

Activity III-1

film from the listed resources

film projector

discussion questions in hand-out, ditto form

Activity III-2

paper and pen or pencil

Activity III-3

any resource materials available from library or science room

Activity III-4

water colors, crayolas or magic marker

map of Texas (from Chapter II)

Activity III-5

6 X 9 inch cake pan

plaster of paris

bucket to mix plaster in

leaves

black paint

spoon

paint brush

water

grease for pan

Activity III-6

several samples of peat, lignite, bituminous and anthracite coal

microscope

Extra--bar-be-que pit, hot dogs, skewers, picnic paraphenalia

Activity III-7

vocabulary list in hand-out, ditto form and dictionaries

TEST

1. Coke is used in making

    A. tires

    B. aluminum

  * C. steel

    D. bottled soft drinks

2. The United States is the second largest producer of coal behind

  * A. U.S.S.R.

    B. Great Britain

    C. Japan

    D. Chile

3. In the United States, what amount of heat and power does coal supply?

    A. 1/20

    B. 1/10

    C. 1/8

  * D. 1/5

4. What stage of coal formation is peat?

  * A. first

    B. second

    C. third

    D. fourth

5. How much water is in peat?

    A. 0 - 10%

    B. 15 - 35%

    C. 40 - 65%

  * D. 70 - 95%

6. One of the first resources used by early settlers in Texas was

A. bituminous coal

* B. lignite

C. anthracite coal

D. peat

7. Bituminous coal is softer than

* A. anthracite coal

B. lignite

C. pine wood

D. peat

8. The United States estimated coal reserves could last us about

A. two years

B. 20 years

* C. 200 years

D. 2000 years

9. The primary source of coal supplying the steel industry today comes from

A. Southwestern United States

* B. Eastern United States

C. Western United States

D. Midwest United States

10. Anthracite is "hard coal" found mostly in

A. Texas

B. Wyoming

* C. Pennsylvania

D. Georgia

RESOURCE LIST

Publications

Alder, Irving and Ruth. Coal, Day, 1965. A book for young readers describing what coal is, where it comes from, and how it is changed into a variety of other products.

Anders, Henry. Ancient Plants and the Work They Lived In. Ithaca, New York: Cornell University Press, 1947.

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Geology of Houston and Vicinity Texas. Houston, Texas: Houston Geological Society, 1961.

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"Coal: America's Most Abundant Fuel," Science Teacher, V. 41, Nov. 74, p. 18.

"Clean Power from Dirty Fuels," Scientific American, V. 227, Oct. 72,

"The Gasification of Coal," Scientific American, V. 230, Mar. 74, p. 19.

"The Rise of Coal Technology," Scientific American, V. 231, Aug. 74, p. 92.

"Coal is Cheap, Hated, Abundant, Filthy, Needed," Smithsonian, Feb. 73.

"The Challenge and the Promise of Coal," Technology Review, V. 76, Dec. 73, p. 20.

"The Economics of Coal-Based Synthetic Gas," Technology Review, V. 77, Aug. 75, p. 42.

"Coal Gasification Offers One Key to Energy Independence," Commerce Today, V. 4, Jan. 7, 74, pp. 4-6.

Films

Fuel For the Future, available from the American Natural Gas Service Company, One Woodard Avenue, Detroit, Michigan 48226. This film contains a section on coal gasification.

The Coal Connection, available from the Utah Power and Light Company, 1407 West North Temple, P. O. Box 899, Salt Lake City, Utah 84110. Much of this film is devoted to mining coal. The film also explains how electricity is generated, hydroelectric power, geothermal and nuclear power, oil and gas generation facilities as well as coal facilities.

Energy vs. Ecology, available from the Modern Talking Picture Service, 4804 Westheimer Road, Houston, Texas 77027. This film covers the topic of reclaiming land in Ohio after coal mining. There is extensive detail on coal mining, land reclamation, and air pollution resulting from burning the coal to generate electricity.

ENCORE

Chapter 4

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. draw a picture of an atom with neutrons, protons, nucleus, electrons and shells.
2. list at least three ways of producing electricity.
3. draw flow charts and name the basic parts of a natural-gas fired power plant, a hydroelectric power plant and a nuclear power plant.
4. define a list of vocabulary words related to electrical energy and electricity production

ELECTRICAL ENERGY PRODUCTION

One should consider the basic structure of the atom in the study of electricity, since electricity is related to the structure of an atom.

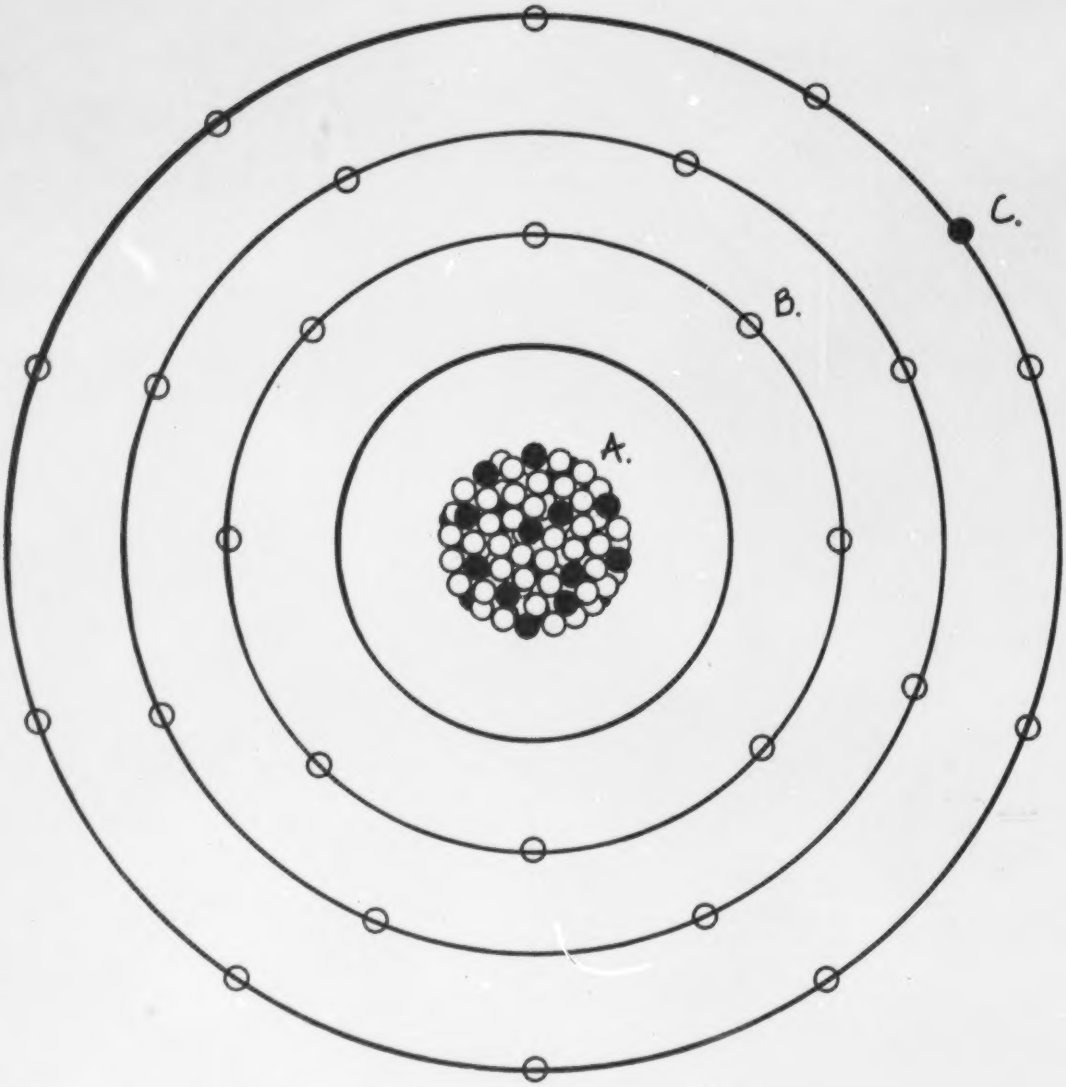
The atom, in its basic form, contains neutrons, protons, and electrons. Neutrons have neutral charges, protons have positive charges and electrons have negative charges. The neutrons and protons are grouped together in the center of an atom, forming a nucleus. The electrons are in orbit around the nucleus (Figure IV-1). Each atom has one or more shells. A shell is an orbit which contains a specific number of electrons and are arranged in order.

The number of electrons in the outer shell of an atom determines the electrical characteristic of an element. In general, an element whose atoms contain less than three electrons in their outer shells will conduct electricity. Those elements whose atoms contain four or more electrons in their outer shells are semi-conductors or non-conductors of electricity. The elements copper, silver and gold have atoms that contain one electron in the outer shell; that makes them excellent conductors of electricity.

Since a copper atom has only one electron in the outer shell, it always wants to give off the extra electron so it can be stable. The extra electrons that are given off are called free electrons. Electricity or electrical current is the orderly movement of electrons between the outer shells of neighboring atoms. The force which moves these electrons is exerted between the ends of a conductor (wire). The force is a difference in the number of electrons at one end of the conductor and the number at the other end. The free electrons are constantly trying to move to the end where there are fewer electrons, in order to balance the number of electrons at each end. This difference of electrons is called voltage and is measured in

80

THE COPPER ATOM



A. Nucleus

B. Electrons

C. Free Electron

Figure IV - 1

volts (V). The electric current is measured in amps. Amps measure the number of electrons that flow past a certain point in a conductor. A watt measures electric power. Watts = Volts X Amps.

Producing Electricity

Every power plant has an energy source, a turbine and a generator. The energy source is heat from burning oil, natural gas, coal, heat from a controlled nuclear reaction or flowing water. A turbine turns a generator to produce mechanical energy. The generator then takes the mechanical energy and changes it into electrical energy. To understand how this change takes place, remember the previous discussion of the atoms and the free electrons. It is important to remember that the movement of free electrons is electricity.

Now, how does a generator move those free electrons? Very simply, inside a generator there is a magnet and a coil of wire. The wire is usually made of an element such as copper, because copper is a good conductor of electricity. The atoms are close together, so their outer shells overlap. While in motion, the free electron of one atom can migrate from one atom to another. The free electron of the second atom also randomly migrates and so on. Most of the outer electrons continually change orbits in a random manner; and as long as the free electrons wander randomly, the copper wire is "dead".

Magnets, as you probably have observed, will either attract each other or they will repel each other. The repelling or attracting is due to a magnet's force fields. The force fields are the secret of producing electricity, because when a coil of copper wire spins inside the force field of a magnet, the copper coil "cuts" the lines of the force field. The force field will provide enough energy to cause the free electrons in the outer shell of the copper atoms to move in a certain direction (Figure IV-2). These free electrons moving in one certain direction is electrical current, or electricity!

The electrical current produced by a generator can be either an alternating current (A.C.) or a direct current (D.C.). An alternating current changes direction periodically. As a coil rotates, against the force field lines and then with the force field lines, current is produced in the wire first in one direction and then in the other.

In Figure IV-3 the circle represents the coil; it is marked off at 0°, 90°, 180°, and 270°. The north pole and the south pole of the magnet are drawn with the force field lines in-between. The line graph, on the right, is the same length as the circumference of the circle and it is also marked off at 0°, 90°, 180°, and 270°.

The voltage (or force of the current) depends on how many force field lines are cut in a unit of time. For example, if several lines are cut in 1 milli-second then the voltage is high; if only a few lines are cut in 1 milli-second then the voltage is low. So, when point A on the coil moves from 0° to 90° it begins cutting only a few lines at 0°, but it cuts more and more as it reaches 90°. The line graph shows how the voltage goes up between 0° and 90° when the coil is spinning against the force field lines. When point A moves from 90° to 180°, it begins to cut several lines, but it cuts less and less as it reaches 180°. The line graph shows how the voltage goes down between 90° and 180° when the coil is spinning with the force field lines. When point A moves from 180° to 270° it begins to cut only a few lines at 180°, then more and more as it reaches 270°. The line graph shows how the voltage goes down between 180° and 270° when the coil

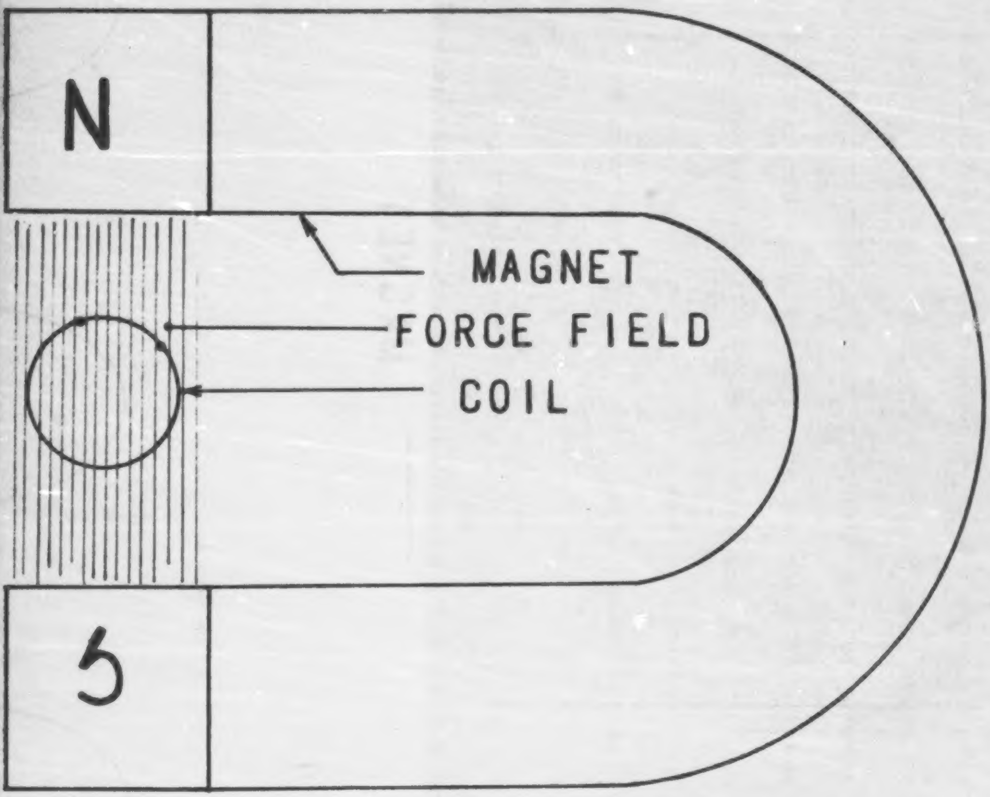

N
MAGNET
FORCE FIELD
COIL
S

Figure IV - 2

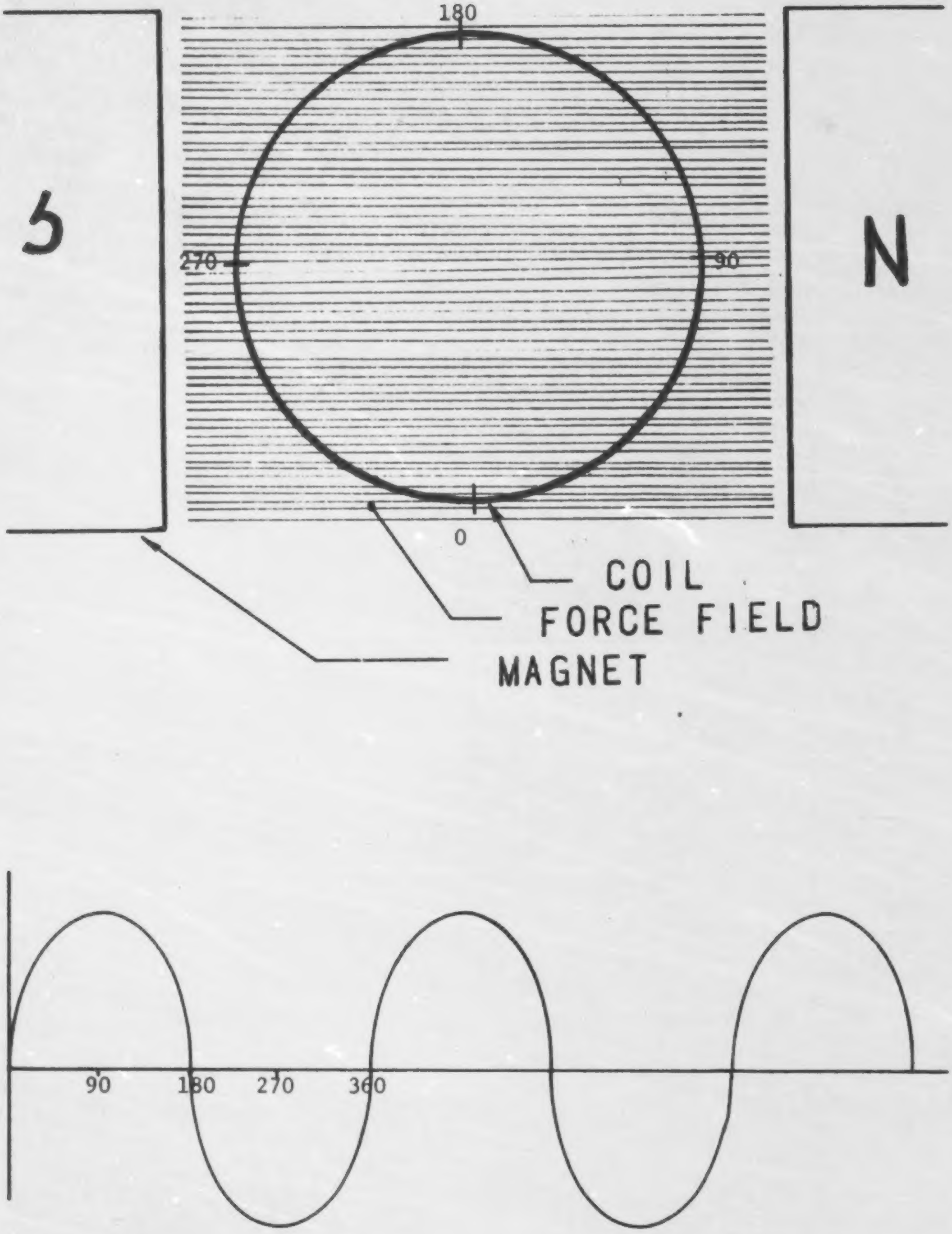

180
S
270
90
N
0
COIL
FORCE FIELD
MAGNET
90
180
270
360

Figure IV - 3

is spinning with the force field lines. You can see for yourself what happens as point A moves from 270° back to 0°.

Over 90% of the current used in electrical circuits is alternating current (A.C.).

A direct current is obtained by placing a special device on the generator called a commutator. The commutator reverses the current during every half cycle. Its line graph is shown in Figure IV-4 below.

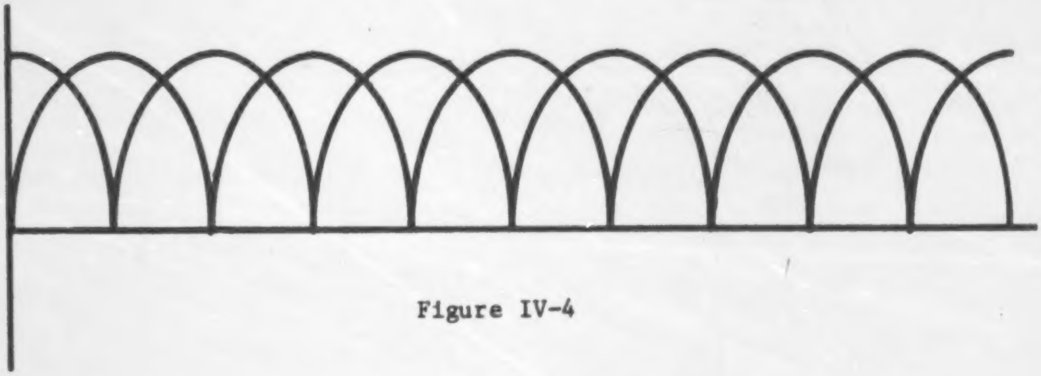


Figure IV-4

Direct current always flows in the same direction where alternating current changes direction periodically.

Another point to consider is that a generator can have more than just one coil of wire and more than just one magnetic force field. If there are several coils in a generator spinning through a four-pole magnetic field then more current could be produced in the same amount of time.

Finally, when current is produced in a coil of wire, it flows to slip rings and then the brushes carry it from the generator.

Having discussed the energy sources, and the generator, the turbine should be discussed. The turbine is a fancy name for a fan. Usually a turbine is constructed with precision because it must operate at high temperatures and at high speeds. Gas or steam strikes the turbine blades and exerts force on the blades which causes the turbine, which is connected to a shaft, to rotate, producing mechanical energy. The turbine turns a generator, and produces electricity.

At present there are two ways of producing electricity from natural gas. One method, the gas-turbine electric generator, uses the heat produced by burning natural gas to produce mechanical energy that turns a turbine. The turbine turns a generator, producing electricity. In actuality, this is nothing more than using a jet engine to produce electricity. The other method, the natural gas fired-boiler turbine generator (see Figures IV-5 and 6). uses the heat of burning natural gas to boil water and steam turns a turbine connected to a generator, producing electricity. The natural gas fired-boiler turbine generator is most frequently used.

A second method of producing electricity is by using the power generated by moving water from a waterfall or from damming a river. This is called hydroelectric power, and this type of plant comprises about 18% of all the power plants in the United States (see Figures IV-7 and 8). The hydroelectric power plant uses the motion of the water to turn a turbine wheel which turns a generator, producing electricity.

The third method of producing electricity covered in this chapter is the nuclear reaction method which uses uranium for its fuel (see Figures IV-9 and 10). When a nuclear reactor is used to produce electricity, the atomic energy is converted to heat energy which heats water, which produces steam, which turns a turbine converting the heat energy into mechanical energy. The turbine turns a generator which converts mechanical energy into electrical energy for our use. It is really very simple in principle, but it is more complicated in practice; that is why only 19% of our power comes from nuclear energy.

NATURAL GAS-FIRED BOILER TURBINE GENERATOR ENERGY CONVERSION FLOW CHART

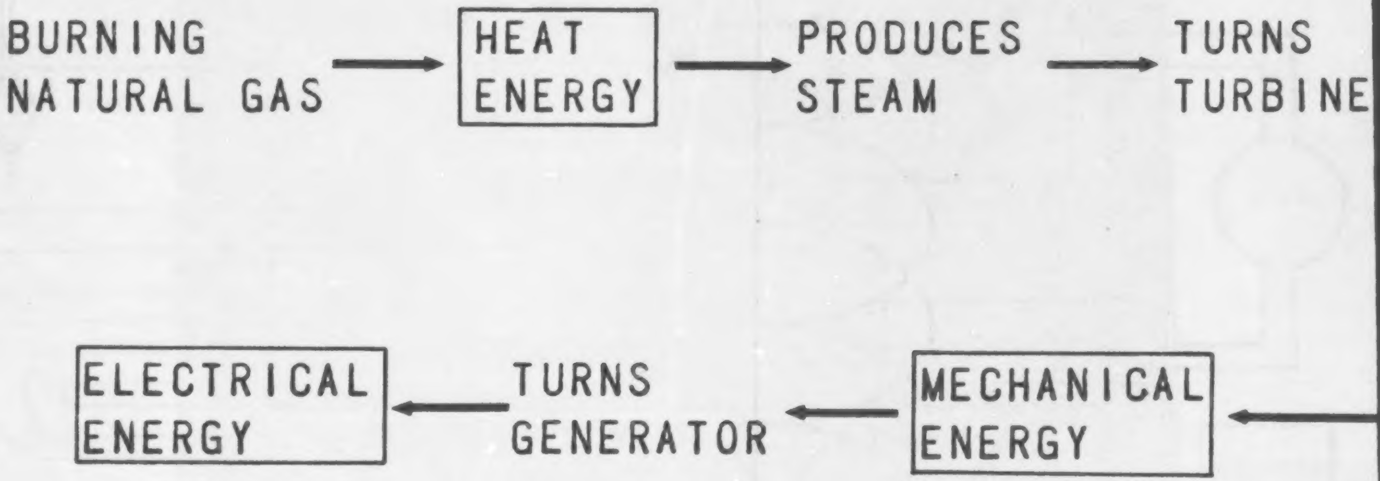
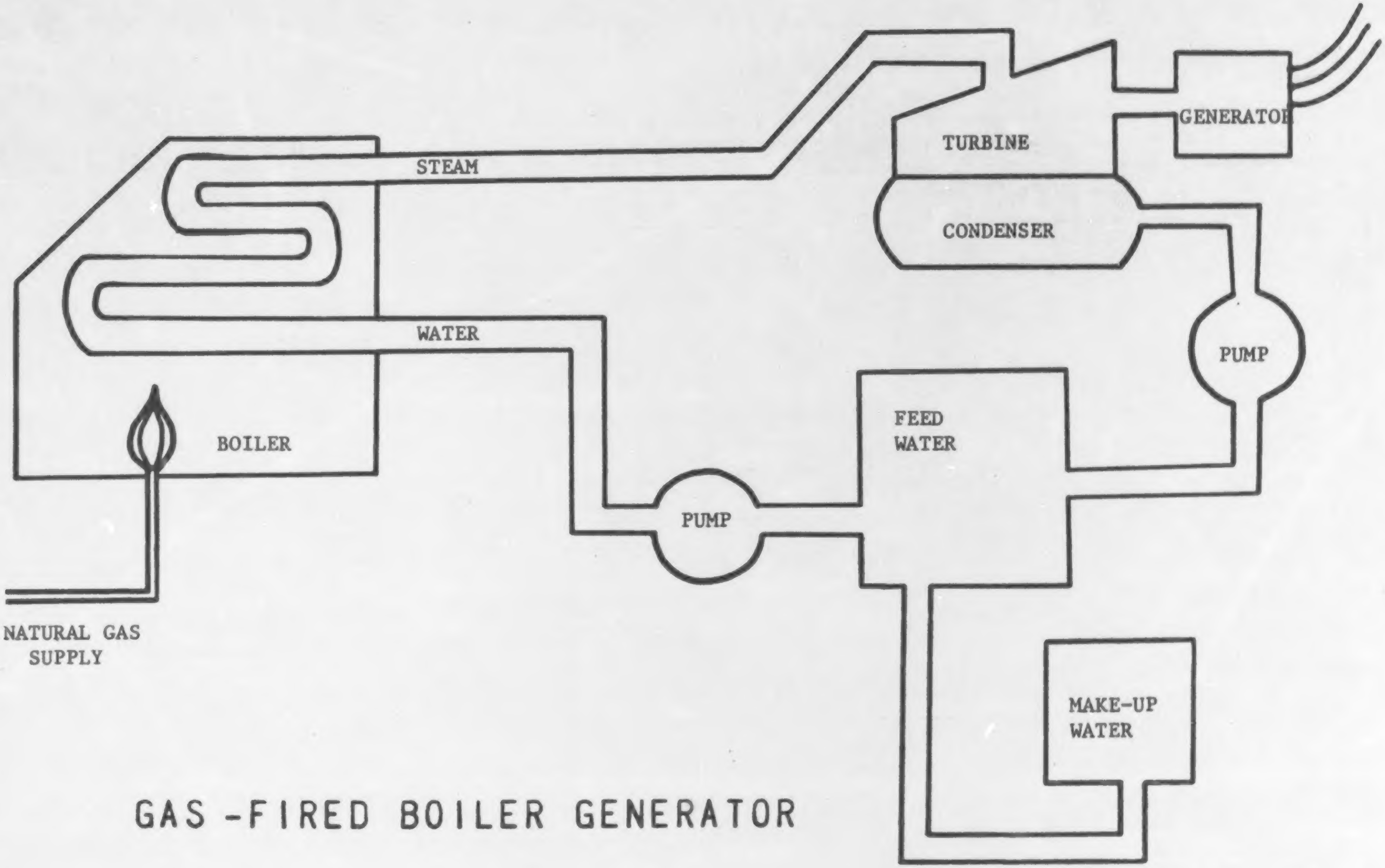

BURNING NATURAL GAS
HEAT ENERGY
PRODUCES STEAM
TURNS TURBINE
MECHANICAL ENERGY
TURNS GENERATOR
ELECTRICAL ENERGY

Figure IV


STEAM
TURBINE
GENERATOR
CONDENSER
WATER
PUMP
FEED WATER
BOILER
PUMP
NATURAL GAS SUPPLY
MAKE-UP WATER

GAS-FIRED BOILER GENERATOR

Figure IV - 6

HYDROELECTRIC TO ELECTRICAL ENERGY CONVERSION FLOW CHART

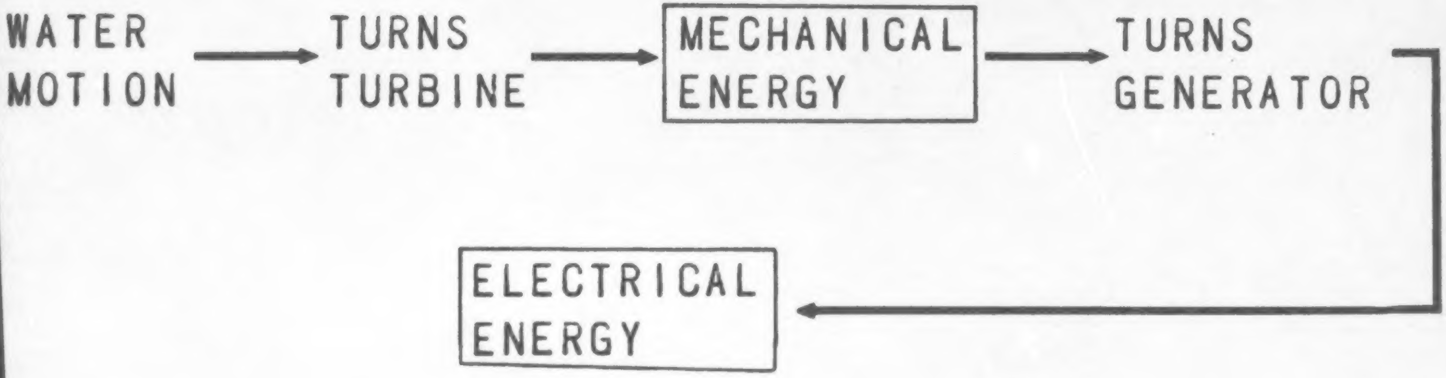
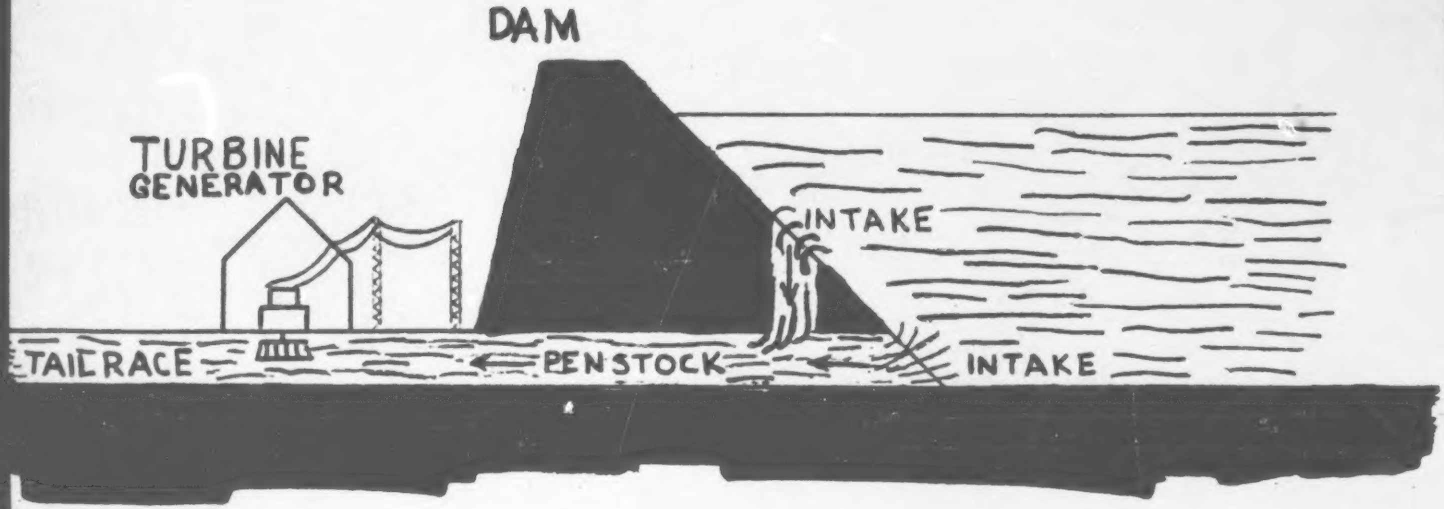

WATER MOTION
TURNS TURBINE
MECHANICAL ENERGY
TURNS GENERATOR
ELECTRICAL ENERGY

Figure IV - 7


DAM
TURBINE GENERATOR
INTAKE
TAILRACE
PENSTOCK
INTAKE

HYDROELECTRIC POWER PLANT

Figure IV - 8

NUCLEAR TO ELECTRICAL ENERGY CONVERSION FLOW CHART

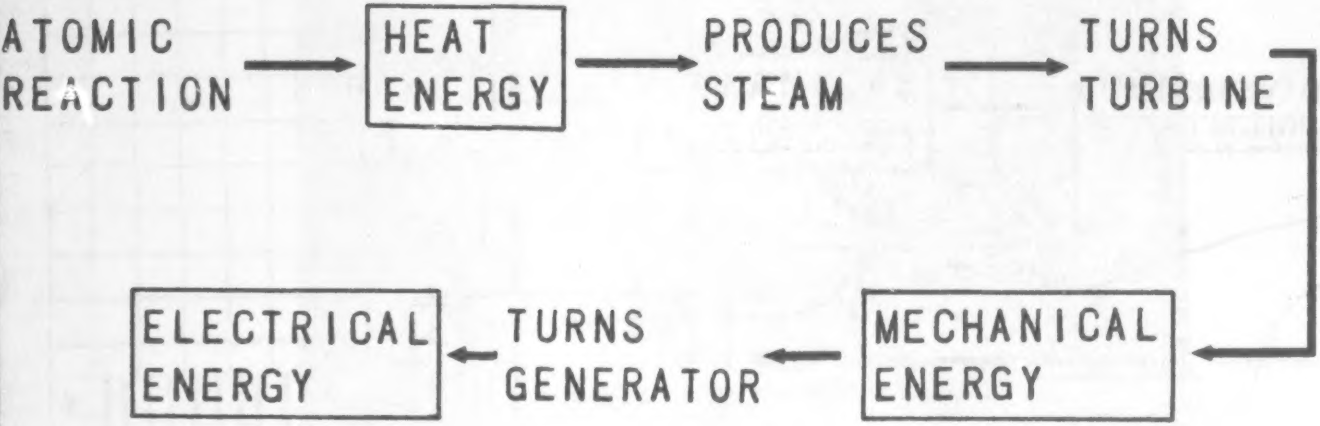
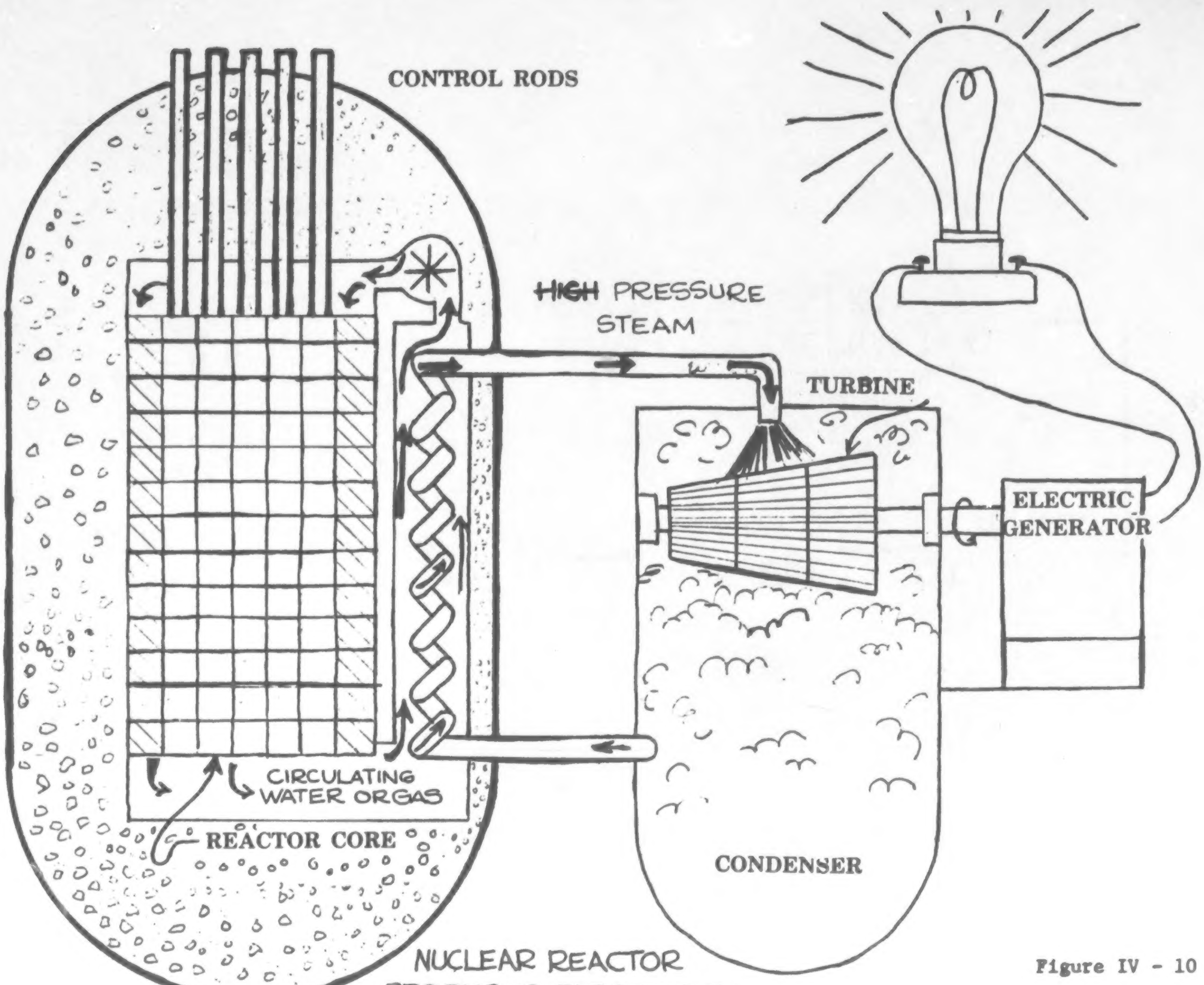

ATOMIC REACTION
HEAT ENERGY
PRODUCES STEAM
TURNS TURBINE
MECHANICAL ENERGY
TURNS GENERATOR
ELECTRICAL ENERGY

Figure IV -


CONTROL RODS
~~HIGH~~ PRESSURE STEAM
TURBINE
ELECTRIC GENERATOR
CIRCULATING WATER OR GAS
REACTOR CORE
CONDENSER

NUCLEAR REACTOR PRODUCING ELECTRICITY

Figure IV - 10

It takes about 10 million pounds of coal a day to produce enough electricity for a city of 750,000 people. A nuclear plant uses only 71 pounds of uranium a day to make the same amount of electricity.

Once the electricity is made at the power plants it is delivered to the people by high voltage transmission lines which run from the power plant to the cities and towns.

The following five pages should help you see the differences between the various forms of electrical energy production.

FORMS OF ELECTRICAL ENERGY PRODUCTION

PETROLEUM

ADVANTAGES:
1. It is easily stored and easily released.
2. It is easily mined; a Mid-East well can flow at a rate of 10,000 barrels per day.
3. It is easily transported, stored, and controlled.

DISADVANTAGES:
1. Once combusted, it is lost forever.
2. It is in very short supply, as are all fossil fuels.
3. Its supply is unsure due to political factors.
4. It is found in relatively few places in the world.
5. Environmental dangers:
   - A.) Atmospheric pollution from carbon dioxide and carbon.

COAL

ADVANTAGES:
1. It is the most abundant fossil fuel.
2. Its stored energy is easily released.
3. It is easily transported, stored, and controlled in a large volume.

DISADVANTAGES:
1. Once combusted, it is gone forever.
2. Environmental dangers:
   - A.) Waste heat, sulfur dioxide, particulate matter, and carbon dioxide may be released after combustion;
   - B.) Deep mining of coal is dangerous; strip mining damages the land produces soil waste problems, acid drainage, unproductive land, and visibly ugly land.

HYDROELECTRIC

ADVANTAGES:

1. Consumes no fossil fuel.
2. Low production costs.
3. Water force conversion to electrical energy is 90%
4. No chemical or thermal pollution.
5. Can be used to electrically produce hydrogen.

DISADVANTAGES:

1. Construction cost is very high.
2. Damming of rivers causes changes in their ecosystems.
3. Sedimentation and silt accumulation affects the river's flow and drainage patterns.
4. Few feasibile sites remaining for development
5. Loss of cropland in river valley

NATURAL GAS

ADVANTAGES:

1. The cleanest of the fossil fuels; it is sulfur free.
2. It is easily stored, transported, and controlled in large amounts.

DISADVANTAGES:

1. Once combusted, it is gone forever.
2. It is a very short supply; known deposits of gas in the U.S. would only last about 11 more years at current output. Natural gas could be imported as a liquified product from foreign suppliers, from gasified coal, or from methane extracted from organic refuse.

NUCLEAR FISSION

ADVANTAGES:
1. SUBSTITUTES OF LOCALLY CONTROLLED RADIOACTIVE WASTE BY-PRODUCTS FOR THE MORE DIFFUSE EMISSIONS OF FOSSIL FUELS.
2. FOR BREEDER REACTORS, A LONGER LIFE EXPECTANCY OF THE FUEL.
3. LOW UPKEEP AND LOW OPERATING COSTS.
4. CONCENTRATED FUEL SUPPLY.

DISADVANTAGES:
1. ENVIRONMENTAL DANGERS:
   - A.) LARGE AMOUNT OF THERMAL POLLUTION;
   - B.) RELEASES RADIOACTIVE WASTES, WHICH MAY REMAIN ACTIVE FOR THOUSANDS OF YEARS;
2. LARGE CAPITAL INVESTMENT TO BUILD.
3. SHORT SUPPLY OF URANIUM--NO MORE THAN 20 YEARS WITHOUT THE BREEDER REACTORS
4. ONLY 33% THERMAL EFFICIENCY.

WIND

ADVANTAGES:
1. IS EVERYWHERE, FREE AND PLENTIFUL.
2. NO ENVIRONMENTAL DAMAGE.
3. NO THERMAL DISADVANTAGES.

DISADVANTAGES:
1. RELATIVELY UNSTABLE OUTPUTS.
2. WIND MUST MOVE AT SPEEDS GREATER THAN 7 MPH

SOLAR

ADVANTAGES:
1. CLEAN SOURCE OF INEXHAUSTABLE ENERGY.
2. DOES NOT INCREASE THE EARTH'S THERMAL BURDEN.
3. SOLAR PLANTS ARE RELATIVELY QUICK AND EASY TO CONSTRUCT.
4. SAFE.
5. SUFFICIENT.

DISADVANTAGES:
1. EARTH-BASED SOLAR CONVERTERS WORK ONLY WHEN THE SUN IS SHINNING; INTERMITTENT, LOW-INTENSITY.
2. INCREASES THE HEAT BURDEN OF THE BIOSPHERE

GEOTHERMAL

ADVANTAGES:
1. PLENTIFUL SUPPLY IN RESTRICTED AREAS.
2. LOWER COST THAN COMPARABLE SIZED PLANTS UTILIZED FOSSIL OR NUCLEAR FUELS.
3. LESS TIME FOR PLANT SET-UP AND OPERATION.

DISADVANTAGES:
1. LOW EFFICIENCY; 30% OF THE OUTPUT MAY BE USED TO RUN THE PUMPS.
2. ENVIRONMENTAL DANGERS:
   - A.) DISPOSAL OF HOT WATER WITH A HIGH MINERAL CONTENT;
   - B.) DISPOSAL OF HOT WATER PRODUCED BY CONDENSATION IN THE CONVERSION PROCESS;
   - C.) RELEASES NOXIOUS GASES INTO THE ATMOSPHERE---SULFUR, AMMONIA, BORON.

NUCLEAR FUSION

ADVANTAGES: 1. Large fuel supply
2. Less long-lived dangerous wastes than with fission.
3. Very low accident risk
4. Fuel processing done at reactor site.
5. Requires no combustion of the earth's oxygen.
6. No air emissions.

DISADVANTAGES: 1. Not technically feasible at the present time.
2. May have significant amounts of tritium leakage.
3. May have large amounts of thermal pollution

ACTIVITIES

1. Make a styrofoam and wire model of a copper atom (Activity IV-1).
2. Make a puzzle to show how electricity is made. The pieces can be the eight different steps of the electricity production and transmission process. See if your classmates can put the pieces in order (Activity IV-2).
3. Complete the Pedal Power activity (Activity IV-3).
4. Construct a working turbine generating unit (Activity IV-4).
5. Construct a working hydroelectric generating unit, using the previously constructed turbine generating unit (Activity IV-5).
6. Invite a representative from the local power company to visit the class and discuss how the electricity in your area is produced. Be an attentive audience and have good questions ready for the representative when he comes (Activity IV-6).
7. Define vocabulary words (Activity IV-7).

Making A Copper Atom Model

(Activity IV-1)

For this activity, refer to Figure IV-1 (the drawing of a finished copper atom model). Gather the necessary materials listed on the materials list.

First, take seven coat hangers and straighten out the wire. You will need four pieces of wire about 5 1/2 feet, 4 1/2 feet, 3 1/2 feet, and 2 1/2 feet long. On the longer pieces, two coat hangers will have to be connected together with masking tape. Bend the four wires into four concentric loops and close each loop with masking tape.

Take seven different colors of construction paper. Cut 34 circles about 1/2" - 3/4" in diameter. Write the letter "N" (for neutron) in the center of each of the circles, using a magic marker. Next, cut 29 circles (the same size as before) from another color of construction paper. Write "+" (designating protons) in the center of each circle. From still another color of construction paper, cut 10 circles and write the minus sign "-" on each circle (designating electrons). With the fourth color, cut out 8 circles and write "-" on each. With the fifth color, cut 8 more circles and write "-" on each. With the sixth color, cut 2 circles and write "-" on each. With the last color, cut 1 circle and write "-" on it, also.

Now, take the styrofoam ball and a box of straight pins. Pin the 34 circles (marked "N's") and the 29 circles (marked "+'s") on the styrofoam ball. Mix the circles up--they represent neutrons and protons in a nucleus of an atom.

Next, tape the 2 circles of one color with "-"'s on them on the smallest wire loop. Tape the 8 circles of another color on the second-smallest wire loop. Tape the other 8 circles on the next-to-largest wire loop. Finally, tape the 10 circles of one color and the 1 circle of another color on the largest wire loop. At this point, all the colored circles are either pinned to the styrofoam ball, or they are taped to the four wire loops; every circle is in place. If you prefer, each paper circle on the wire loops can have a front and a back (taped together) so your model will look nice on each side. Just cut twice as many circles of each color. Be sure to put either "N", "+", or "-" on the circles so they match their front side.

Next, take a 24 inch piece of string. Lay the wire loops on the table, so the loops are concentric. About 10 inches from one end of the string, tie a know around the largest wire loop. Making sure the loops are still concentric, tie a knot around each loop. With the leftover string, attach the styrofoam ball so it hangs in the center of the smallest loop. You can glue the string to the ball, tie the string to a paperclip and push the paperclip into the styrofoam, or use tape. When the glue dries, the copper atom can be hung from the ceiling.

Generating Electricity with Pedal Power

(Activity IV-3)

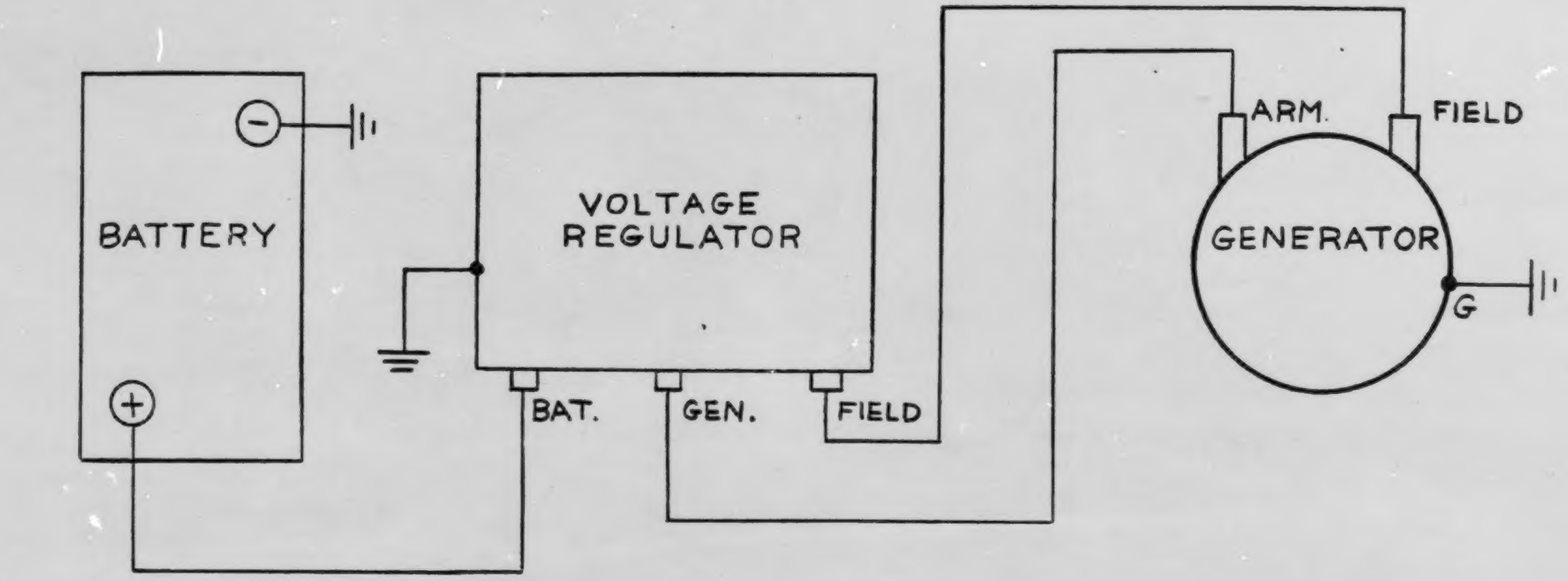
The bicycle generator is designed to replenish a charge to a storage battery. The battery then can be used to power a 12 volt light, a tape deck, radio or other small device. Use your imagination. Run a few experiments using the ampmeter and voltmeter. Measure the amount of amps and volts being generated by the bicycle at different speeds. Calculate the rpm's (revolutions per minute) of the generator by following the example provided.

If the diameter of the rear wheel of the bicycle equals 26 inches and the diameter of the generator pulley is 3 inches, 26 divided by 3 is almost 9. So the ratio of the bicycle wheel to the generator pulley is approximately 9 to 1. One turn of the rear wheel turns the generator pulley 9 times, 2 turns of the bicycle wheel turns the pulley 18 times, and so on. Also, one turn of the bicycle pedal turns the rear wheel 2 1/3 turns. So, if one turn of the bicycle pedal turns the rear wheel 2 1/3 turns, and one turn of the rear wheel turns the generator pulley nine times, then one turn of the pedal turns the generator pulley 21 turns because:

$$(1)\ (2\ 1/3)\ (9) = 21 \text{ turns!}$$

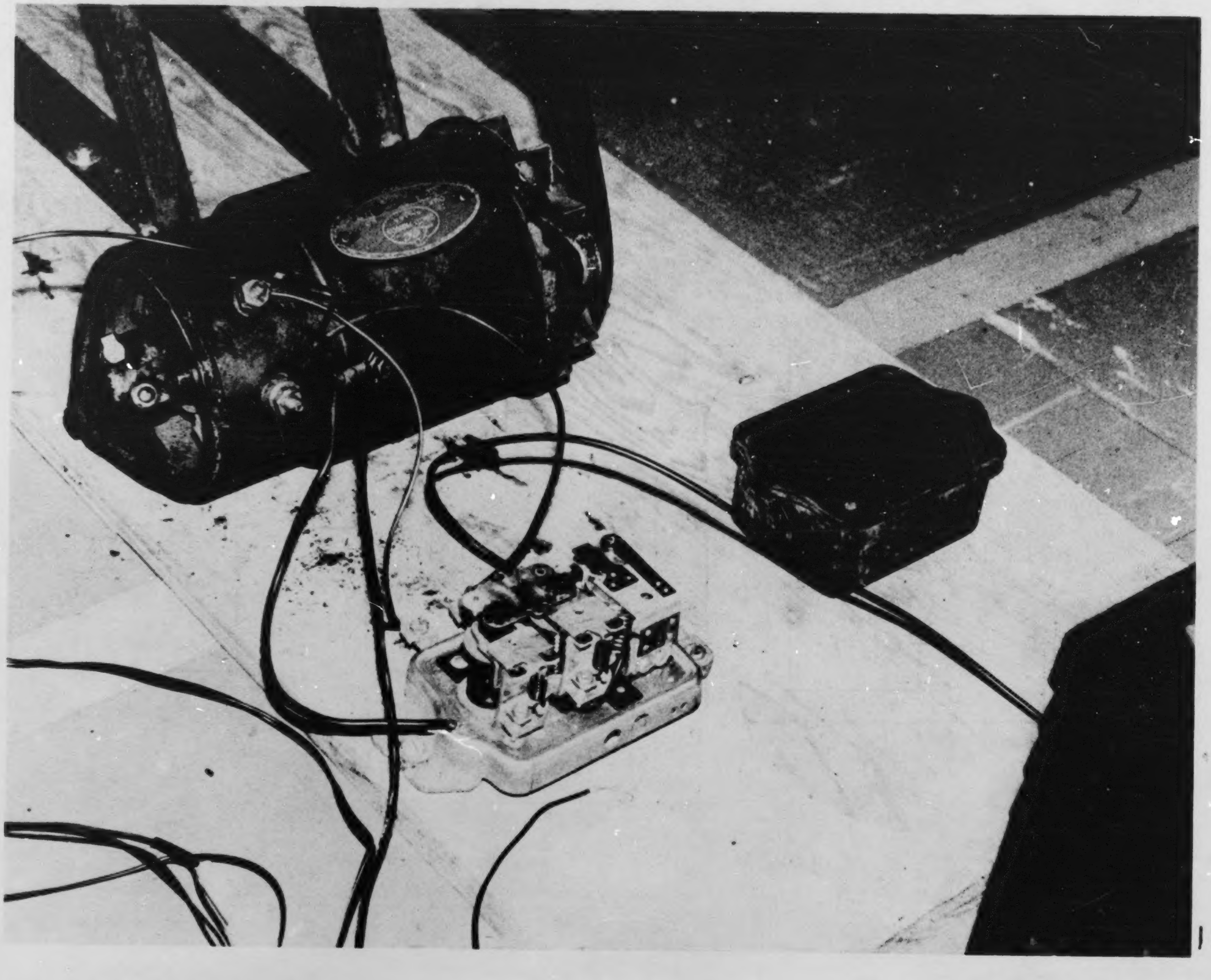
If you rotate the bicycle pedals 9 times every 5 seconds, you are turning the equivalent of about 2200 rpm's because:

$$(9)\ (21)\ (12) = 2268 \text{ rpm's.}$$


BATTERY
VOLTAGE REGULATOR
BAT.
GEN.
FIELD
ARM.
FIELD
GENERATOR
G

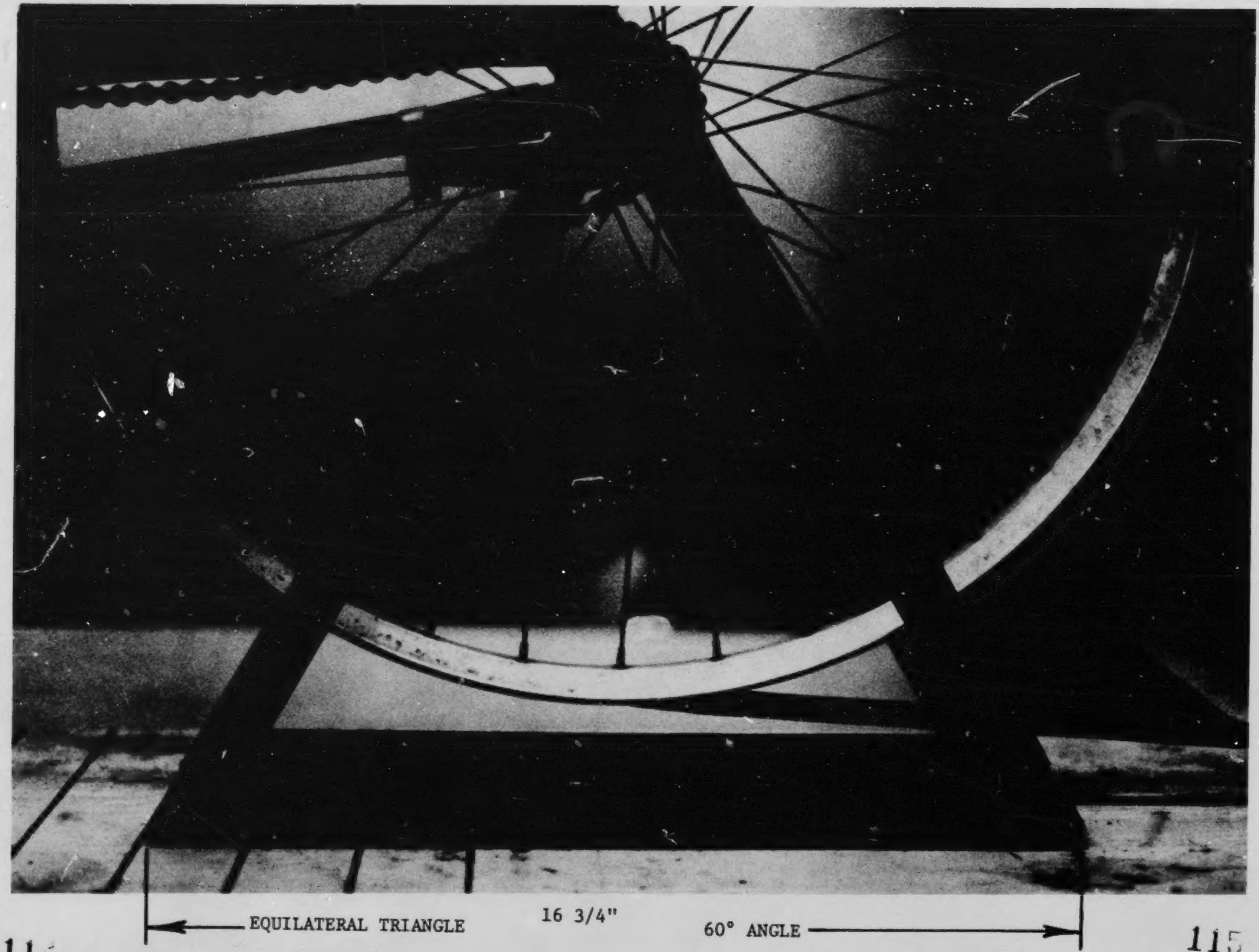
TYPICAL REGULATOR-GENERATOR ELECTRICAL CONNECTION

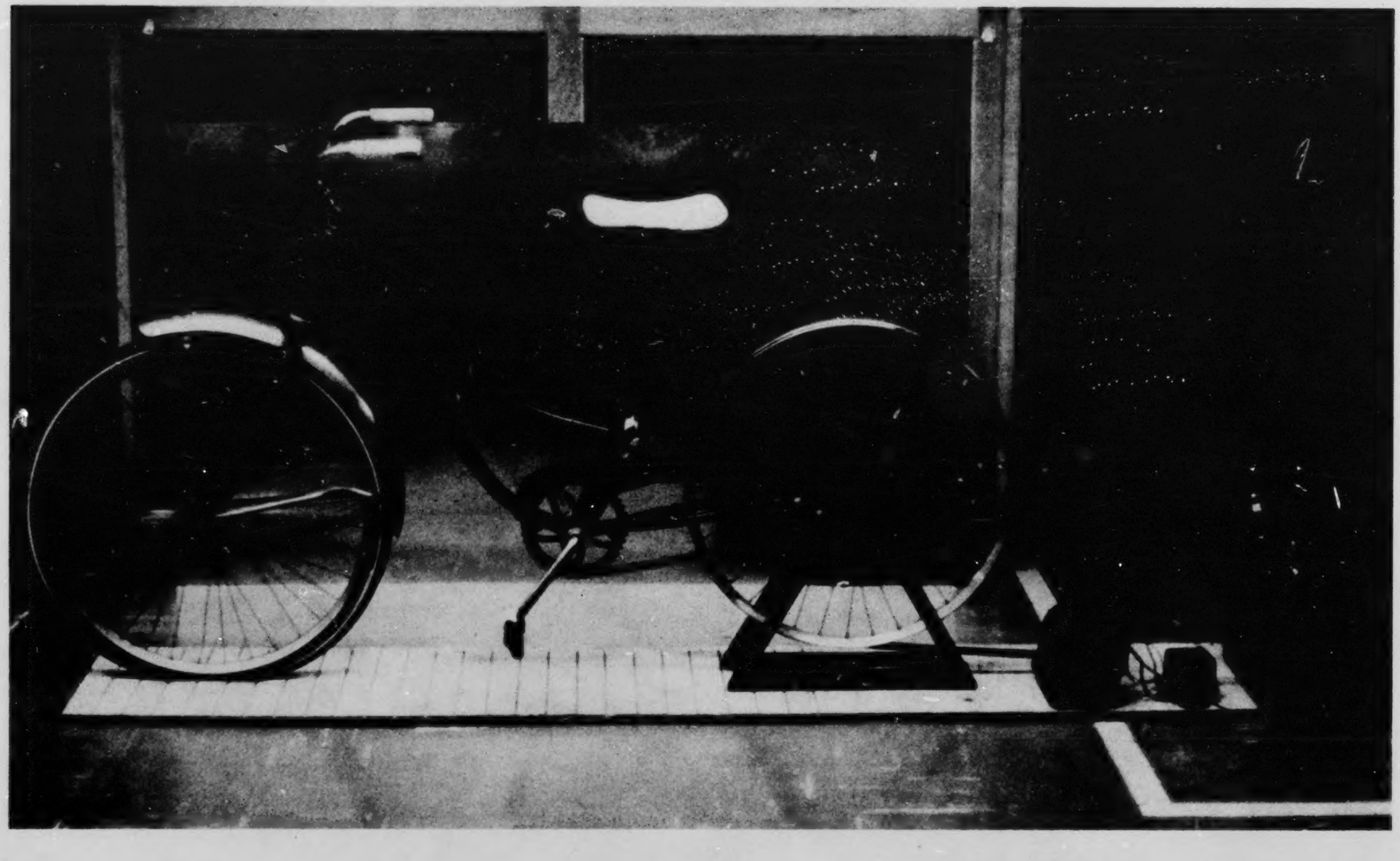
112



11

113

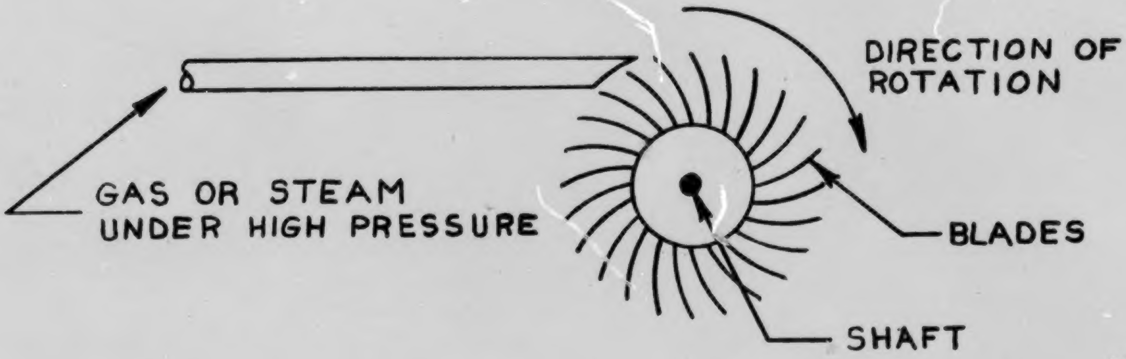

EQUILATERAL TRIANGLE
16 3/4"
60° ANGLE


26" BICYCLE
12 VOLT GENERATOR
12 VOLT BATTERY
12 VOLT VOLTAGE REGULATOR

Turbine Generator

(Activity IV-4)

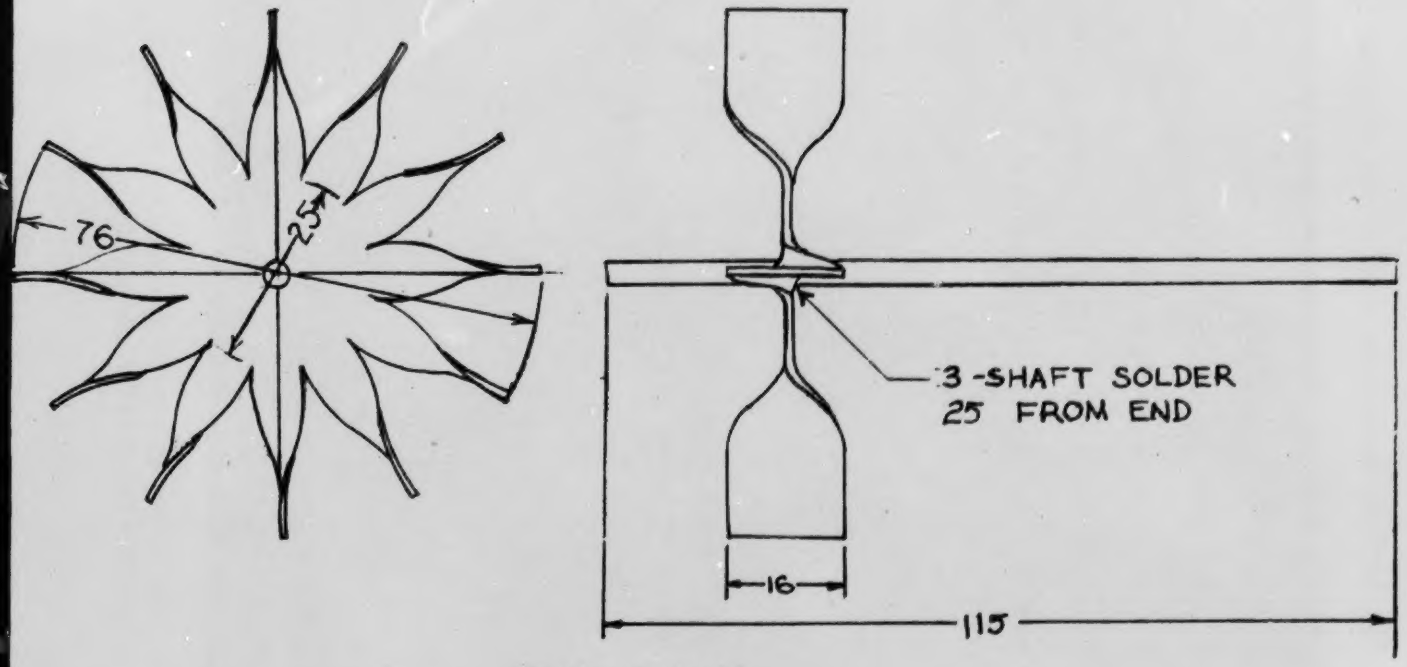
The turbine works like a fan. Gas or steam is allowed to hit the blade of the turbine. The pressure from the gas or steam exerts force on the blades which causes the turbine, which is connected to a shaft, to rotate - producing mechanical energy, which if connected to a generator may be used to produce electricity. A turbine is usually constructed to exacting precision because it must operate at high temperatures and at high speeds. Its operation is illustrated in the drawing below.



Procedure

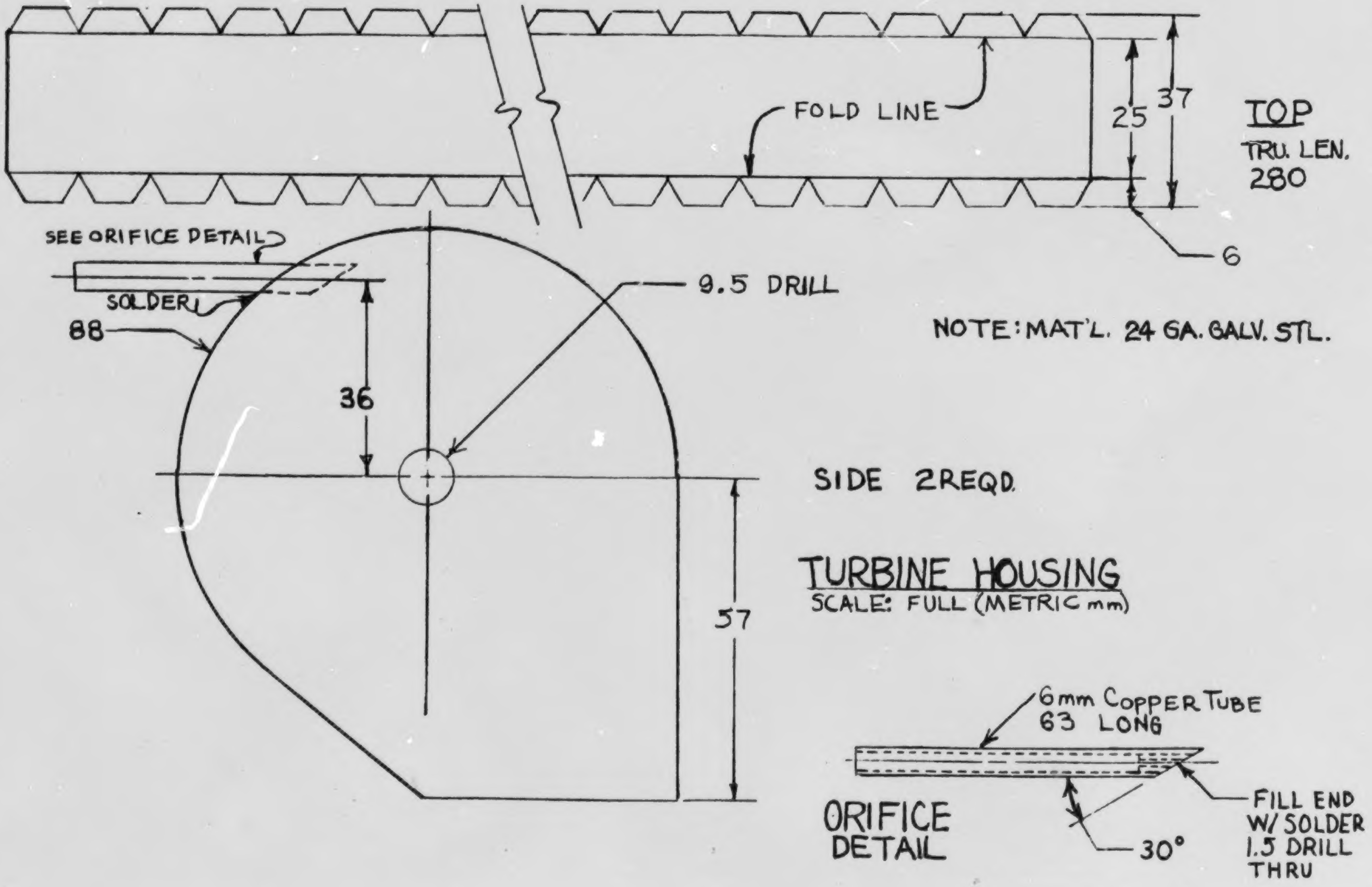
1. Obtain a set of plans for the turbine-generating unit.
2. Obtain necessary materials.
3. Using the plans and instructions from your teacher, construct the turbine generator.
4. Pay close attention to accuracy in layout, cutting, and assembling turbine generator.

NOTE: TURBINE CONST.
FROM 24 GA. GALV. STL.
LAY-OUT BLADES AND
TWIST 90 ANGLE W/PLIER
AFTER CUTTING.



3 -SHAFT SOLDER
25 FROM END

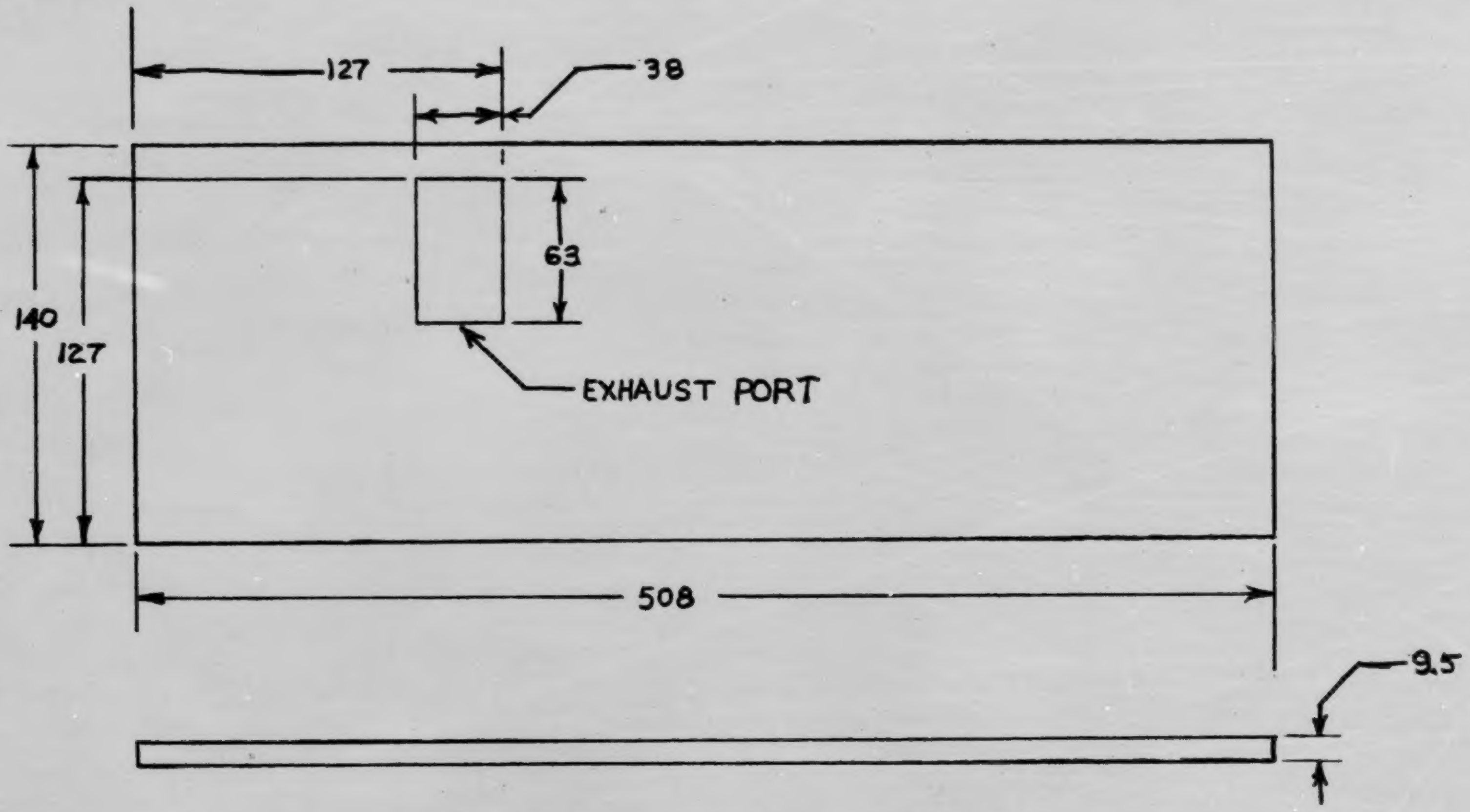
TURBINE
FULL (METRIC mm)



FOLD LINE
25
37
TOP
TRU. LEN. 280
6
SEE ORIFICE DETAIL
SOLDER
88
9.5 DRILL
36
NOTE: MAT'L. 24 GA. GALV. STL.
SIDE 2REQD.
57
6mm COPPER TUBE 63 LONG
FILL END W/ SOLDER 1.5 DRILL THRU
30°
ORIFICE DETAIL

TURBINE HOUSING

SCALE: FULL (METRIC mm)


127
38
63
140
127
EXHAUST PORT
508
9.5

BASE MAT.-24 GA. GALV. STL.
SCALE: 1=3 (METRIC-mm)

Hydroelectric Generating Unit

(Activity IV-5)

In this activity you will have an opportunity to assemble a model which contains all the essential parts of a hydroelectric generating system.

Procedure

1. Set up the apparatus as shown in the illustration.
2. Remember Figure IV-8 which shows the major parts of a hydroelectric plant. Using that drawing, name the following parts which represent a part on the hydroelectric system.

   A. The water faucet ______________________

   B. The hose from the faucet to the turbine ______________________

   C. The sink drain ______________________

3. Turn on the water very gently so that very little water is flowing in the tube.
4. Is the turbine turning? ____________________
5. Increase the water pressure. Is the turbine turning now? _________ If not, increase until the turbine turns very slowly. Record the meter reading. ____________________________
6. Increase the pressure a small amount. What happens to the speed of the turbine?

   ____

7. As the pressure is increased, record the meter reading.

   ____

8. Increase the water pressure to the maximum, set by your instructor. Record the meter reading.

   ____

9. Feel the side of the turbine housing. Is it cold or hot? _________

Conclusions

1. Does this experiment duplicate the action of a hydroelectric plant?

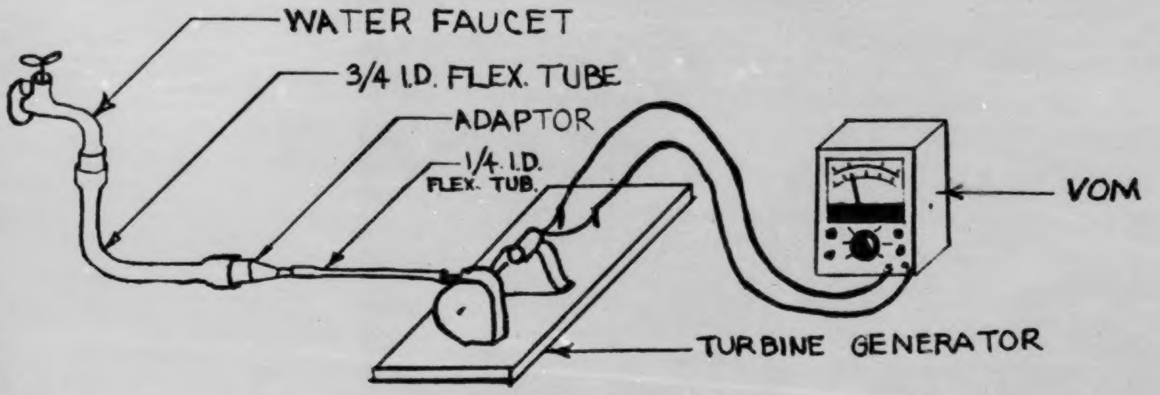
2. What effect does the water pressure have on the turbine?

3. What effect does the water pressure have on the meter reading?

4. What effect does the water pressure have in terms of the amount of electricity being produced?

5. Is there any heat energy wasted?

6. Is there any energy wasted at all?


WATER FAUCET
3/4 I.D. FLEX. TUBE
ADAPTOR
1/4 I.D. FLEX. TUB.
VOM
TURBINE GENERATOR

SET-UP DIAGRAM - HYDROELECTRIC GENERATOR

Vocabulary

(Activity IV-7)

1. alternating current (A.C.) -
2. atom -
3. conductor -
4. copper -
5. current -
6. direct current (D.C.) -
7. electron -
8. free electrons -
9. generator -
10. insulator -
11. magnetic field -
12. neutron -
13. nuclear reaction -
14. nucleus -
15. proton -
16. radiation -
17. transformers -
18. turbine -
19. voltage -

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide an overview of the fundamental concepts of electricity and three methods of electricity production and distribution.

The activities listed here are varied. Some are complex and others are relatively simple. The copper atom model can be a group activity and can be used as a display. Activity IV-2 reveals the distribution aspects of electricity production. This is an individual activity that can be done as an art activity. The Pedal Power activity is more complex, but the final product is extremely entertaining. That particular activity has been constructed and used in a local energy fair, to draw the communities' attention to the energy crisis. Constructing a turbine also takes a little time, but an impressive product, that can be used at displays or fairs, is created. The fifth activity uses the previously constructed turbine to create a hydroelectric-generating unit. The students are impressed with their capabilities, if allowed to complete these construction activities. Having a speaker in the classroom is a very beneficial learning experience; perhaps even a field trip could be arranged. Let the students make as many of the necessary arrangements for the speaker as they can. The vocabulary list may be helpful in fostering comprehension.

At least three of these activities are involved. Ask the metals shop instructor or the electronics instructor for help, if necessary. Many of these activities can be used as displays in the community or the school office. Get as many people involved as possible.

List of Materials

Activity IV-1

7 wire coat hangers (or 16 feet of some type wire)

wire cutters

scissors

magic marker

7 different colors of construction paper

box of straight pins

a 3 inch diameter styrofoam ball

glue

tape

2 feet of string

Figure IV-1

Activity IV-2

scissors

construction paper

magic markers, crayolas, pen, map pencils

example puzzle in hand-out form

Activity IV-3

26 inch bicycle

generator

voltage regulator

12 volt battery

V-belt

3/8" X 1 1/2" bolts, nuts and washers (to mount generator)

1/4" X 1" bolts, nuts and washers (to mount bicycle stand)

8 ft. of 12 gauge insulated wiring

8 1/2 ft. of 1/8" X 1" angle iron

8 welding rods (3/16")

2 medium battery clamps

1 piece of 3/4" X 15" X 6' fur plywood

2 light bulbs, 12 volt-50 watt

electrical outlet

8 track tape deck (car)

Activity IV-4

3 square feet of 24 gauge galvanized steel sheetmetal

6 inches of 1/8 inch brass rod (may substitute available material)

a permanent magnetic hobby motor and acid core solder

3 inches nylon rod, 3/8 inch diameter

2 inches of 1/4 inch O.D. copper tubing

Miscellaneous hardware (pop rivets, screws, steel wool)

Tin snips

Sheetmetal shear

Dividers

24 inch bench rule

Oxygen/Acetylene torch (or equivalent heat source)

Drill press

Files

Activity IV-7

Vocabulary list in hand-out form

pen or pencil

TEST

1. An atom has

* A. a nucleus and one or more shells

B. two nuclei and four skins

C. no nucleus, only orbits

D. none of the above

2. The three parts of an atom are

A. the top, bottom and side

B. the left, right and middle

* C. the protons, neutrons and electrons

D. the circles, rings and dots

3. Electricity is

A. electrons flowing in a random manner

B. electrons standing still

* C. electrons flowing in an orderly manner

D. protons jumping up and down

4. Copper

A. has one electron in its outer shell

B. is a good conductor

C. is used in electric wires

* D. all of the above

5. Which of the following fuels is not used in electricity production?

A. natural gas

B. coal

C. uranium

* D. butane

6. What carries electricity from the power plant to the people?

* A. transmission lines

B. horses

C. telephone lines

D. laser beams

7. A generator produces electricity with

A. a fuel pump

* B. coils of wire and a magnetic field

C. a coil of wire and a protector shield

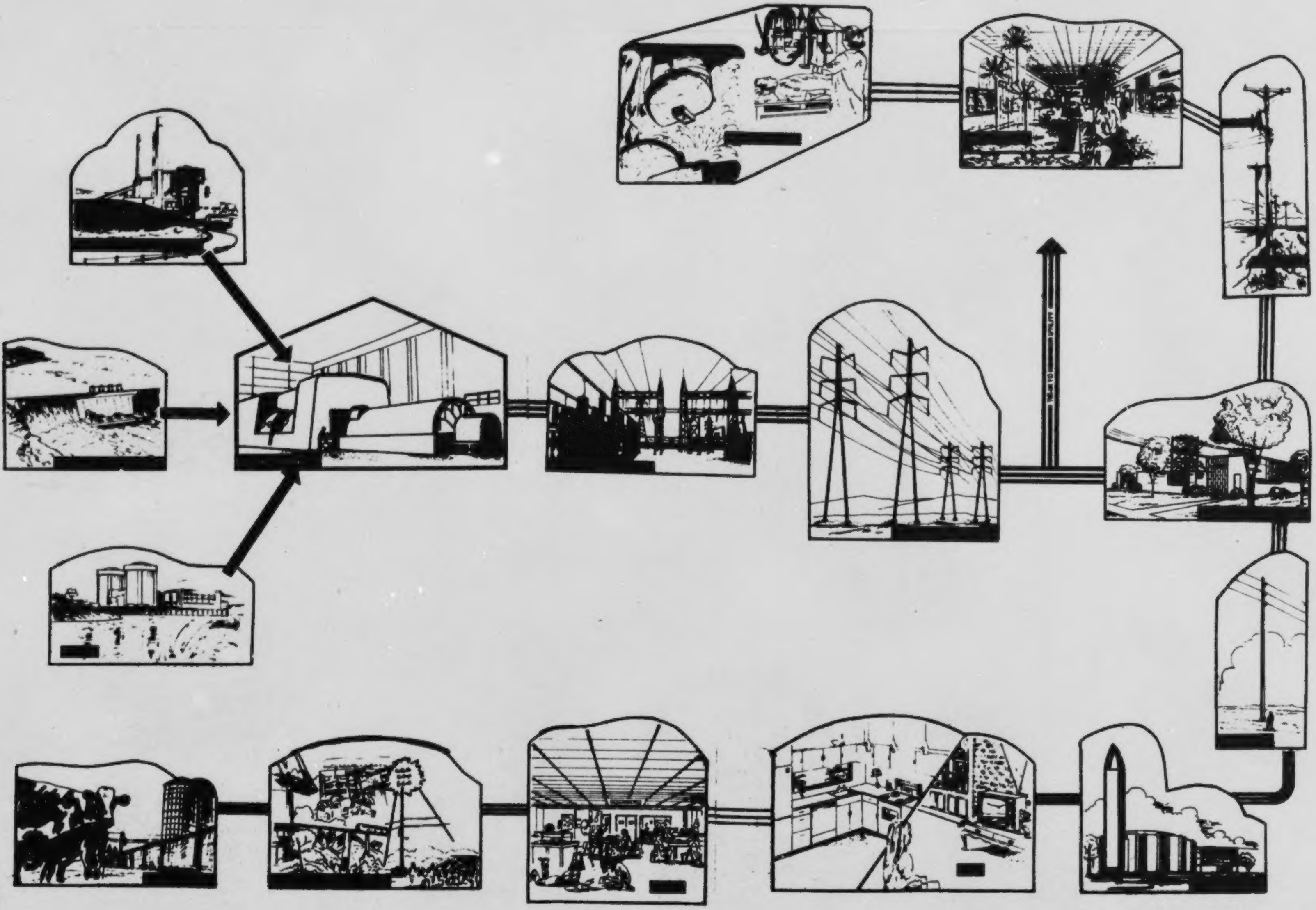
D. seven squirrels in a squirrel cage

8. Draw a flow chart illustrating the conversion of the energy of natural gas into electricity by a natural gas-fired boiler turbine generator.

9. Draw a flow chart illustrating the conversion of the kinetic energy of falling water into electricity by a hydroelectric plant.

10. Draw a flow chart illustrating the conversion of nuclear energy into electricity by a nuclear power plant.

Answer Key to Activity IV-2



RESOURCE LIST

Publications

"A Nuclear Primer," Gulf General Atomic Company, Pittsburgh, Pennsylvania.

"A Teacher's Handbook," Colorado Department of Education, Denver, CO 80203.

"Battle for Survival," Consumers Power Company, Educational Services Program, Room 893 C, 212 W. Michigan Avenue, Jackson, MI 49201.

"Energy Alternatives: A Comparative Analysis," Service and Public Policy Program, University of Oklahoma, Norman, Oklahoma.

Energy and The Environment: Electric Power, Council on Environmental Quality, August, 1973.

"Family Energy Watch Calendar," Department of Energy, State of Oregon, Salem, Oregon.

"Gas Centered Projects for Science Fairs," (#N00470), Educational Services, American Gas Association, 1515 Wilson Boulevard, Arlington, VA 22209.

"Instant Power," Consumers Power Company, Education Service Program, Room 893C, 212 W. Michigan Avenue, Jackson, MI 49201.

Ludington-Pumped Storage Hydroelectric Plant, Consumers Power Company, same as above.

"Nuclear Power for Tomorrow," Gulf General Atomic Company, Pittsburgh, PA.

"Power When You Need It," Consumers Power Company, listed above.

Springborn, Harold W. The Story of Natural Gas Energy, Educational Services, American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.

"The Energy Directory," Environment Information Center, 124 East 39th Street, New York, NY 10016.

Films

Challenge of the Future, #0508, ERDA Film Library, Technical Information Center, P. O. Box 62, Oak Ridge, TN 37830.

Nuclear Power in the United States, #0468, ERDA Film Library, listed above.

The Coal Connection, Utah Power and Light Co., 1407 West North Temple, Salt Lake City, Utah 84110 (free loan).

The Energy Crisis: Environment, NBC Educational Enterprises, 30 Rockefeller Plaza, New York, NY 10020 ($20 rental).

ENCORE

Chapter 5

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. correctly answer a set of discussion questions related to energy production and pollution.
2. discuss and complete three experiments about air and water pollution.
3. develop his/her own opinion and attitude about energy production and pollution through a role-playing situation.
4. define a set of vocabulary words related to environmental quality and energy.

ENVIRONMENTAL QUALITY AND ENERGY

Look around you. No, really look around you and what do you see? You see a world of wonderous beauty, a world filled with an untold number of living things. Yet, we face the threat of someday seeing only barren, desolate land where many forms of life once thrived in a land of seemingly limitless natural resources. What poses this threat? What endangers all living things--both plant and animal? The most intelligent, organized, highly-developed animal life-form, the "caretaker" of the earth--man. Truly, man poses the greatest threat to life as we now know it. Very few people realize that converting fossil fuels and nuclear fuels into energy pollutes the air, land, and water, and contributes to solid waste.

Air Pollution

Air pollution is defined as the presence of undesirable substances in the air, in sufficient quantities to interfere with man's comfort, safety, or health, or in the full use and enjoyment of his property.

In 1970, 264 million tons of air pollutants were emitted. Automobiles and other transportation forms contributed to over one-half the total number of emissions. Automobile emissions include carbon monoxide (56%), sulfur oxides (13%), hydrocarbons (13%), nitrogen oxides (9%), and solid particles, particulate, (9%). But, because of emission control devices, carbon monoxide and hydrocarbon emissions have declined 83% and 90% respectively since 1968. Nitrogen oxide emissions have declined 50% since 1973. Other solutions for controlling automobile emissions include the mass production of the Wankel or rotary combustion engine, electric powered and steam-driven cars, and gas-turbine engines.

The second largest contributor of total emissions are power plants, residential and commercial heating units, steel and non-ferrous metals mills, smelting facilities, industrial plants, and all other stationary sources. Coal-burning power plants produce the most air pollution of this group. They emit sulfur oxides, nitrogen oxides, carbon monoxides and mercury. The most publicized energy/pollution problems are the emissions of the particulates and sulfur oxides.

So far, the most effective method of removing sulfur oxides during the combustion process is through stack-gas sulfur removal systems. The most practical sulfur removal system is the stack gas scrubber. It removes sulfur oxides from a stream of gas by contact with a limestone based slurry (thin mud). The pollutants are trapped in water droplets and then flushed away. Scrubbers cost an average of $80.00 a kilowatt to install and takes about three years from design to operation.

The most effective method of removing particulates is with the use of electrostatic precipitators. An electrical charge is imparted to the gas stream, giving the particles a positive charge. These positively charged particles are then collected on a negatively charged plate, which is constantly shaken by a vibrator, causing the particles to fall into a dust bin.

Two other types of air pollution control devices are mechanical collectors and fabric filters. Fabric filters operate like huge vacuum cleaners and collect the fine industrial dust particles from gas before it is emitted from the stacks. Fabric filters cannot be used if the gases are extremely hot. Most mechanical collectors do not meet the new air quality standards, so they are installed only with other systems.

air quality standards, so they are installed only with other systems.

Oil-burning power plants release about one-third as much air pollution as coal-burning power plants. Residual domestic oil, when burned, emits primarily sulfur oxides and nitrogen oxides. Burning imported oils may cause significant quantities of vanadium to be released into the atmosphere, but for the United States imported oil is the cleanest, not because of different sulfur or ash content, but because the oil is extracted and refined abroad. (From a global perspective, this factor is not relevant.)

Natural gas-burning electric power plants emit minor amounts of carbon monoxide and nitrogen oxide; the total emissions being 5% of the total emissions from a coal-burning power plant.

Nuclear power plants do not create air pollution.

It is understandable that industries are reluctant to use the costly emission control devices, if the following factors are considered. A comprehensive survey by the McGraw-Hill Economics Department released in May 1976 indicated that American business planned to spend some $5.17 billion for air pollution control. Removing the pollutants from coal-burning power plants may cause the cost of electricity to rise 30%. When emission control devices are used, they create solid waste that has to be disposed of or recycled. Furthermore, there is no conclusive evidence that sulfur oxides are a health hazard.

It is a fact that we are rapidly destroying our air quality, but the problem can be viewed from many different perspectives. Consider this: all the air pollution that man has produced on this earth does not even equal the amount of particulates and gases from just three volcanic eruptions--Krakatau in Java in 1883, Mt. Katmai in Alaska in 1912, and Kekla in Iceland in 1947. Particles from Krakatau were in the atmosphere for two or three years. Bloomers disintegrated on the clotheslines in Vancouver, B.C., for six months after Mt. Katmai erupted, due to the effect of sulfur dioxide on the silk material (Pecora, Director of the U.S. Geological Survey, Department of the Interior).

Water Pollution

Water pollution has already affected the quality of the water that we drink. Realizing this, Congress passed the 1972 Water Pollution Act Amendments and a rules timetable was set up to eliminate the discharge of all pollutants into the nation's waters by 1985. However, it is not 1985, so raw sewage and chemical wastes are still being indiscriminantly emptied into our waterways.

Many of the chemical wastes not only pollute the water, but become a costly burden to industries. If methods of reclaiming these chemicals could be perfected, both the industries involved and our precious environment would be benefited. Some chemical reclaiming methods are being used in certain parts of the country even now.

Junk and discarded materials such as old cars, tires, plastic containers, and glass can be found extending many miles into the oceans. These items are disrupting the natural environmental balance in the water systems. Many of the discarded materials--cars, tires, and glass containers--could be recycled into usable materials.

Many non-biodegradable detergents, which contain phosphate are still being used. If there are large amounts of phosphate in the water, then there is a population explosion of phosphate-absorbing algae. Algae collects on top of the water and consumes all of the available oxygen;

suffocating the aquatic life beneath. Biodegradable detergents are now available to help minimize water pollution. The biodegradable detergents can be broken down by micro-organisms living in the water. The containers of all detergents are clearly marked to indicate whether the detergent is biodegradable or contains phosphates.

Our energy-producing industries also contribute a vast amount of pollution to water. Of all the energy resources, coal produces the most water pollution. It isn't the coal burning power plants that pollute our water, but the coal mining process. From coal extractions alone, the Department of the Interior estimates that acid leakage from mines, and silt run-off spoil 13,000 miles of streams and 145,000 acres of lakes and reservoirs. Seventy percent of all coal is cleaned before being transported to the user to reduce inorganic sulfur and ash content. This produces waste water which often pollutes streams with suspended solids.

The production of oil also causes many water pollution problems. Crude oil is usually found mixed with brine (salt water). Sometimes not all of the crude oil is extracted from the brine, so when the brine is disposed of, it is dumped into inland waterways and the ocean. This severely contaminates fresh water supplies and affects marine ecosystems. When oil tankers clean their bilges (the lowest inner part of a ship's hull), the oily waste-water is discharged into the ocean. Whenever oil is taken from the ground and stored or transported, there is the danger of oil being spilled into the water from offshore drilling rigs, piplines, storage tanks, or shipping accidents. Oil spills not only damage the water environment or ecosystem, but may also destroy wetlands used for spawning as well as land used for recreation.

The production of natural gas also produces considerable amounts of brine which has to be disposed of, but a natural-gas power plant does not create water pollution.

Nuclear power plants do not create any water pollution, but in the processing of uranium, a very small amount of radioactive liquid is released, which must be converted into solids within five years. The U.S. Atomic Energy Commission regulations require that shipment to a federal repository take place within ten years.

To prevent pollutants from reaching our water supply, sewage treatment plants could be built. These treatment plants are necessary to insure the reduction of pollution in our waterways, but are often costly to the taxpayer. Truly, is there any price too great to pay for a clean and healthy environment? If water is to be suitable for human use, it must go through three stages of treatment: primary, secondary, and tertiary. According to the E.P.A., over 60% of the total population is receiving at least secondary treatment of waste-water, but 35% is receiving only primary treatment, and about 5% is getting no treatment at all.

The primary treatment for water that is to be used for human consumption, removes any solids from the water that could damage equipment or interfer in the treatment process later. First, solids are removed by screening the water to remove floating objects and then passing the water into a chamber where sand and grit settle. Next, the suspended solids settle out into a sedimentation tank, collecting on the bottom as sludge. Lastly, the water is chlorinated which kills disease-causing bacteria and reduces odor. This primary treatment only prepares the water for secondary treatment; the water is still not ready for human use.

The secondary treatment further cleans the water with biological processes, and it can be done two different ways. One method is called the trickling filter method, consisting of a bed of stones or synthetic materials. Bacteria on the stones consume most of the organic material in the water as it passes through the stones. The second method is called the activated sludge (a type of mud) process which mixes water, air, and bacteria-filled sludge together. This mixture is held for several hours while the sediment settles. Chlorine is added last, completing the process. The sludge process is more efficient and less expensive than the trickling filter process.

The third treatment further purifies the water by one of five different ways. One method, called clarification, uses chemicals which bunches particles together into large masses that can be easily removed. Another process, called carbon absorption, removes over 98% of the organic matter left in the water by passing the water through activated charcoal. A third process, called electrodialysis, separates the particles from the water with electrical charges. A fourth method uses the principle of reverse osmosis where molecules of water are forced through a semi-permeable membrane--actually removing the water from the waste instead of removing the waste from the water. In the last method, called distillation, the water is heated and turned to steam. The steam is then collected and cooled to liquid form.

In order for industry to meet environmental standards, only primary and secondary treatment procedures are used. From an industrial standpoint, primary treatment removes any solids that would otherwise settle on river bottoms. The water is held in settling tanks where solids drop to the bottom and are removed as sludge. The sludge is dried and burned for energy, or used as landfill. Secondary treatment removes dissolved organic compounds by converting most of them to harmless carbon dioxide and water. The water is held in an aeration pond and oxygen is added to the water. In the oxygen-enriched water, bacteria multiply rapidly, eating the organic materials, producing harmless carbon dioxide and water.

If this water were discharged into a river or lake before most of the organic materials were consumed by the bacteria in the aeration pond, there might be an unnatural rise in the natural bacteria population in the river. If the number of river bacteria grew, they would need more oxygen, ultimately suffocating the aquatic life in the river.

A survey by the McGraw-Hill Economics Department showed that American business planned to spend $3.17 billion for water pollution control in 1976 because of the regulations of the Water Pollution Act Amendments. From the standpoint of the business man, this is not good. Businesses everywhere will have to spend money on pollution controls without any return on their investment.

Thermal Pollution

Any use of energy, including steam-powered electrical plants, gives off waste heat. Once the steam has been used to spin the turbines in a power plant, it must pass through a condenser. In the condenser, cool water is piped in from a lake, river, or ocean. The hot steam comes in contact with the cool water pipes; it lowers the temperature of the steam so that it changes back to water which is piped back to the boiler to be made into steam again. So, the water from the lake, river or ocean is hotter than normal when it is returned to its source.

Thermal or heat pollution is a common problem for the waters located next to electric power plants. Though not well understood, thermal pollution may degrade or benefit the delicate balance of aquatic life in the body of water. The EPA has stated that about 1,000 steam power plants in operation discharge about 50 trillion gallons (or about 15% of the total flow of U.S. rivers and streams) of water annually. The effects of heated water depend on the size of the water body, the climate, the rate and constancy of the thermal discharge, and the uses of the body of water. The production of energy from coal, oil or natural gas-fired power plants causes approximately the same amounts of thermal pollution. But, according to the Council on Environmental Quality, some types of nuclear power plants create as much as 40% more thermal water pollution than any fossil-fueled power plant.

There are several methods used to cool the heated water, such as: cooling towers, cooling ponds, mechanized spraying systems and air-cooled heat exchangers. Cooling towers are the most effective. There are two types of cooling towers--the mechanical draft tower and the natural draft tower. In the mechanical draft tower, fans blow air through the tower. The water is cooled by evaporation. When part of the water evaporates, it takes heat energy with it, leaving cooled water behind. In the natural draft tower, the difference in the warm moist air inside the tower and the cool air outside the tower creates a natural draft. Like the mechanical draft tower, the water is cooled by evaporation.

Cooling ponds are large, man-made lakes which cool through conduction and evaporation on the surface of the lake. Mechanical spraying systems are usually used with cooling ponds.

To control thermal pollution, electric generating companies will have to spend several billion dollars on control equipment, if they are to meet the EPA regulations set for 1990.

Land Pollution

As of 1965, surface mining had affected over 3 million acres of land—only about a third of this land has been restored. Since 1965, approximately 1 million more acres have been affected by surface mining. Deep coal mines undermined over 7 million acres of land, of which over 2 million acres has already subsided. By the year 2000, over 4 million more acres of land may be undermined (compare this area to the area of the state of Massachusetts, which has about 5 million acres). Not only does the production of fuels necessary for electrical production cause massive amounts of land use, but it also diminishes the natural beauty of the land.

Drilling for oil disrupts the environment and land also. Oil rigs and related equipment are unsightly, and there is always the possibility of ruptured pipelines and oil spills. Pipeline right-of-ways occupy large amounts of land.

Natural gas extraction destroys land in about the same manner as oil extraction.

Uranium ore for nuclear power plants has to be surface mined or mined underground, but the transmission line right-of-ways are the primary land users for the nuclear system.

Electrical utilities have over 3 million miles of overhead transmission lines, with 4 million acres of right-of-way. By the year 2000, there may be about 4.5 million more acres added to this. This use of land, projected into the year 2000, would equal an area larger than the area of Delaware and Maryland combined.

Solid Waste

It has been estimated that individuals, industry, and commerce generate between 8 and 10 pounds of solid waste per capita each day. Solid waste includes such things as animal and vegetable wastes, rubber, plastic, wood, steel, nonferrous metals, paper, and other combustible and non-combustible wastes. Some wastes burn slowly, giving off harmful and dangerous gases, they occupy land, and the run-off and leaching of some wastes damages surface and gound water quality.

Of the 4.3 billion tons of solid waste produced in the United States annually, about 40% is from mining. Furthermore, when coal is cleaned, solid wastes are produced in large quantities and piled onto waste banks.

Solid wastes from oil and natural gas-fired power plants are negligible.

Also, nuclear power plants produce solid wastes that may be radioactive for thousands of years after they are used and, consequently, require very careful disposal. From nuclear power plants, fuel fabrication plants, and reprocessing facilities, over 1 million cubic feet of low level radioactive wastes are produced annually; this figure is expected to quadruple by 1980. The radioactive solid waste is buried in federal or state-controlled burial grounds. Since these wastes may be radioactive for thousands of years after their use, a program of continual monitoring and careful storage are important.

There are several methods used in disposing of solid wastes. These include: dumping, burning, sanitary landfill, recycling, and using solid waste as a source of heat and energy. Dumping solid waste contributes to the contamination of ground water and it provides a breeding ground for rats and other pests. Burning solid waste only adds to the air pollution problem. So the most widely used means of disposal is the sanitary landfill. Everyday, the waste is compacted and at night the waste is covered with a layer of dirt. One problem with the landfill method though, is finding enough open space, especially around big cities. In the near future, the waste from metropolitan areas will probably be compacted in the city and then transported long distances by trucks. Recycling will be the answer to much of the solid waste problem in the far future. As metals, glass, and paper become more expensive to produce, recycling will become more feasible.

A newer approach to the solid waste problem is to convert it into a source of heat and energy. If wastes can be burned without producing air pollution, then it can be used to heat buildings and generate electricity. Turning decaying garbage into substitute oil and natural gas is a possibility for disposal. Sometimes the waste is collected, ground up, shredded, crushed, compacted and used as a substitute fuel to produce steam for generating plants.

Technology has provided processes and products to relieve most of the pollutants, but the cost is high. Therefore, efforts to improve the situation have had only limited success thus far.

ACTIVITIES

1. Answer the discussion questions (Activity V-1).
2. Complete the Water Pollution Experiment (Activity V-2).
3. Complete the Air Particle Experiment (Activity V-3).
4. Complete the role-playing activity (Activity V-4).
5. View the slide presentation "Chile Today, Hot Tamale" (Activity V-5).
6. Complete "Should You Shower or Take a Tub Bath?" (Activity V-6).
7. Complete "A Little Drip Means a Big Energy Waster" (Activity V-7).
8. Define vocabulary words (Activity V-8).

Discussion Questions

(Activity V-1)

On a separate sheet of notebook paper, answer the following ten questions. You may need to review the information section of this chapter.

1. What is the largest contributor of air pollutants?
2. What is the second largest contributor of air pollutants?
3. Whenever coal is burned, what elements are released into the atmosphere?
4. Describe two ways that producing oil may lead to pollution.
5. Describe some problems of water and land pollution associated with coal mining.
6. What are some of the problems associated with the solid wastes from the nuclear power plants?
7. Are there people in the United States who drink water that is not clean?
8. Will business men have to spend much money on pollution control devices?
9. Have you ever head of people in the United States getting sick from air pollution? What happened?
10. How can pollution be stopped?

Water Pollution Experiment

(Activity V-2)

Collect samples of water from different places: streams, ponds, puddles and gutters. Each person should collect one sample. When you get back to class, shake up the separate samples and place a teaspoon of each in a separate labeled dish. Let the sample evaporate. After the water evaporates, there will probably be a residue of some sort in each dish.

Discuss the following questions with the rest of your class, after examining the residue in your dish:

1. How did the residue get there?
2. Is the residue harmful?
3. How can the residue be prevented from entering the water?
4. What methods can be used to remove the residue from the water?
5. How does this constitute energy consumption and waste?
6. How could some of this energy have been saved?
7. Explain the ways in which the water purification process uses energy.
8. What will the water (where your sample came from) be like in 10 years, if nothing is done to prevent pollution? What will the water be like in 100 years?

Air Particle Experiment

(Activity V-3)

Solid particles of such things as soot, dust, and pollen are sometimes suspended in the air we breathe. The come from fuel combustion, construction projects and harvesting operations, plus a host of other man-made and natural sources. Eventually these particles are inhaled by men and animals, fall into water supplies or settle on surfaces as dust or sometimes thick grime.

Some kinds of these particles, or particulates, can make men and animals sick. Some foul water supplies and others blacken buildings and coat windows with sludge.

Procedure

1. Gather all the materials needed for the experiment (ask the teacher for a list of materials).
2. Record the weight of each piece of filter paper you plan to use.
3. Select one or more exposure sites for the filter paper; any place where dust collects will do. Weight any tape used to secure the filter paper at the exposure site.
4. After 3 to 7 days weight the filter paper again. Note any increase in weight or change in color of the paper.
5. Use the magnifying glass to note the different sizes, colors and shapes of particles collected on the filter paper.
6. Put some distilled water in a beaker or jar. Test the pH of the water and save the litmus paper.
7. Rinse the particles off the filter paper into the beaker and observe the particles with a magnifying glass.
8. Test the pH of the water with the particles suspended in the water. Compare the litmus paper to that used to test the distilled water in Item 5. Save both litmus papers.
9. Obtain a sample of particulate from a source such as an air conditioner or furnace filter. Rinse the particles into another beaker of distilled water. Observe what happens to the particles, check the pH and compare the litmus papers.

Discuss the following questions with the rest of your group:

1. Did you find evidence of air pollution particulates in your own environment?

2. Did you find that in a short time a significant buildup of particles can occur, even on a small piece of filter paper?

3. Do particulates differ in size, shape and color?

4. Although particulates remain suspended in the atmosphere, do they differ in density and solubility?

5. Does particulate matter from a home filter hold acid chemical compounds which will dissolve in water?

Role-playing: Energy and the Environment

(Activity V-4)

Mr. Free, who lives near Trinity, Texas is having a party; the seven people below are present. Mr. Free has just announced that he has been offered $800,000 for his land. The land is to be used to build an electric generating plant. This is a good location because it is on the river Fuel for the plant, lignite, will be strip-mined, but the leaser assures the landowner that the land will be replanted to grass. At the present time the land is forested and is used by the owner as a game preserve. He has a camp house and allows his family and friends to hunt deer and ducks, in season, and to fish. There are always birds in the area. There are patches of ferns, a few trilliums, wild orchids, and other rare plants.

The seven roles below will be assigned to seven students. After the actors have been decided upon, discuss who they are and how their character might react in this situation. The discussion is very important; it provides the content for the role-playing situation. Every actor should be able to defend his feelings and opinions. The characters are Clyde Brown, Norman Smith, Arthur Jones, Jimmy Free, Cynthia Smith, Alice Free and Free.

Characters:

Clyde Brown--Mr Free's neighbor who has a cattle ranch next to the property

Norman Smith--Mr. Free's neighbor on the other side of the property who has built a $60,000 home in which he planned to live the rest of his life since he has just retired from military service.

Arthur Jones--Another neighbor who has been commuting to Houston (70 miles away) for the past 12 years to work at Houston Power and Light electricity generating plant

Jimmy Free--Mr. Free's only grandson who has spent many holidays and weekends at the camp house and some day assumed he would inherit the property.

Cynthia Smith--Norman Smith's wife in her all-electric home that has become a big headache. Her utility bills have been running about $250 a month, and in the winter the power goes off at sundown when everyone begins to use it heavily and doesn't come on again until about 9 o'clock

Alice Free--Mr. Free's wife who likes to walk in the forest, watch the birds, see the flowers bloom in the spring but has glaucoma and must have expensive eye prescriptions every month.

Joe Free--the landowner.

"Should You Shower or Take a Tub Bath?"

(Activity V-6)

Here's a surprising fact: If people who took tub baths took showers instead, we'd save a lot of energy. This experiment demonstrates what we mean.

Start by taking a bath. Fill your bathtub with water adjusted to the temperature you like best, but before you step in, use your yardstick to measure the depth of water in the tub.

Next, take a shower (better wait till you really need one!). Before you begin, though, do something unusual: close the bathtub drain so that the shower water will collect in the tub. When you are finished (take your time), measure the depth of water that has collected. Compare this reading with the bath water depth.

You will find that your shower used substantially less water . . . probably less than half as much!

"A Little Drip Means a Big Energy Waste"

(Activity V-7)

Each drop of water is tiny, but add all the drops together, and we end up with thousands of gallons of water dripping from the faucet each year. If hot water is dripping down the drain, we are wasting more than clean water . . . we are throwing away the energy used to heat the water.

Here's an experiment that shows you how serious the problem is. If you have a leaky faucet, use it. Otherwise, adjust your kitchen sink faucet (cold water, please) to produce a steady drip.

Simply place the measuring cup underneath the dripping faucet and collect 15 minutes worth of drip. You might, for example, collect four ounces of water in 15 minutes.

Now we have to do some arithmetic to find out how much energy was wasted. Get your pencil and paper as well as your thinking cap. We'll use the four ounce figure in the example below:

Step 1: Multiply the number of ounces of water you collected by 4. (This will give you the number of ounces wasted per hour.)

4 ounces X 4 = 16 ounces per hour

Step 2: Multiply the answer from step 1 by 24. (This gives the number of ounces per day leaking through the faucet.)

16 ounces per hour X 24 = 384 ounces per day

Step 3: Multiply the answer from step 2 by 365. (This gives the number of ounces per year leaking through the faucet.)

384 ounces per day X 365 - 140,160 ounces per year

Step 4: Divide the answer from step 3 by 128. (This gives the number of gallons per year leaking through the faucet.)

140,160 ounces per year ÷ 128 = 1,095 gallons per year

That's a lot of water! And it took a lot of energy to make it hot. You can figure out approximately how much oil, gas, or electricity was wasted by doing the following calculations:

For an oil-fired hot water heater: Divide the answer from step 4 by 110. (This gives the approximate number of gallons of oil wasted.)

1,095 ÷ 110 = 9.95 gallons of oil per year (or less than $4.00)

For a gas-fired hot water heater: Multiply the answer from step 4 by 0.84. (This gives the approximate number of cubic feet of gas.)

1,095 X 0.84 = 920 cubic feet of gas per year (or less than $1.50)

For an electric hot water heater: Multiply the answer from step 4 by 0.25. (This gives the approximate number of kilowatt hours of electricity wasted.)

1,095 X 0.25 = 274 kilowatt hours per year (or less than $11.00)

Energy Costs based on Bryan, Texas Charges

Natural Gas	$1.50/1,000 cu. ft.
Butan or Propane	$.40/gallon
Electricity	$4.49/100kwh
Oil (kerosene)	$.40/gallon

Vocabulary

(Activity V-8)

1. biodegradable -
2. carbon monoxide -
3. condenser -
4. desulfurization -
5. draft -
6. electrostatic precipitators -
7. emission control -
8. hydrocarbons -
9. leaching -
10. mercury -
11. nitrogen oxides -
12. moxious -
13. particulates -
14. phosphate -
15. pollutants -
16. rotary engine -
17. sedimentation -
18. sulfur oxides -
19. vanadium -

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SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide an overview of the various ways conventional production of electrical energy affects our environment. Pollution controls and laws are also discussed in this chapter. This information can be used to motivate and inform the students of the very real problem of pollution. The activities have been selected to insure understanding of the basic concepts related to electricity production and environmental quality.

Students will need to read and discuss the information section before beginning the activities. Necessary materials are listed on the next page. Discussion questions and a role-playing activity are used in this chapter because of the two-sided issues involved. Students have a chance to form their own opinions instead of having to memorize facts. Pollution and water-waste experiments enable students to see waste and pollution problems on a personal level, in their own home or school. The vocabulary list may be helpful in fostering comprehension.

All of these activities, except Activities V-1, V-7, and V-8 can be used as group activities.

List of Materials

Activity V-1

- paper and pencil or pen
- discussion questions in hand-out form

Activity V-2

- glass (to collect water samples)
- teaspoon
- dish (petri dish will be fine)

Activity V-3

- filter paper
- balance or lab scales
- glass jar or beaker
- distilled water
- magnifying glass
- tape and thumb tacks
- pH tester—litmus paper
- pencil and paper

Activity V-5

- slide projector
- slides
- slide script

Activity V-6

- home bathtub
- yardstick or meter stick

Activity V-7

- leaky faucet
- clock
- measuring cup
- pencil and paper

Activity V-8

- pencil and paper

TEST

1. Which of the following contributes most to air pollution?

* A. autos and other transportation forms

B. stationary power generating plants

C. steel and aluminum mills

D. smelters and oil refineries

2. Electrostatic precipitators are used to remove

A. sulfur oxides

B. nitrogen oxides

C. carbon monoxides

* D. particulates

3. Coal-burning power plants produce more air pollution than oil-burning by a factor of

A. 1

B. 2

* C. 3

D. 4

4. Which type of energy produces no air pollution when used to produce electrical power?

A. coal

* B. nuclear

C. oil

D. natural gas

5. The algae population can increase rapidly when the lakes, rivers and streams contain high concentrations of

A. biodegradable detergents

* B. phosphate-form detergents

C. inorganic sulfur and ash from coal

D. junk tires and cans from careless people

6. Which of the following is a waste product of oil production that can contaminate fresh water supplies?

* A. brine

B. inorganic sulfur and ash

C. algae

D. sludge

7. Which type of electrical power plant causes thermal pollution?

A. nuclear

B. coal

C. oil and natural gas

* D. all of the above

8. Several methods are used to cool and heat water from electrical production plants, but the most effective is

A. cooling ponds

B. mechanized spraying systems

* C. cooling towers

D. cooled heat exchangers

9. Cooling ponds are cooled by

* A. evaporation and conduction

B. radiation

C. convection

D. convection and evaporation

10. Nearly 40% of all solid waste generated in the U.S. comes from

A. city refuge

B. nuclear wastes

* C. mining

D. commercial paper mills

Chile Today Hot Tamale

(Slide Presentation: Activity V-5)

Slide	Narration
1. ENCORE	
2. Title:	"Chile Today Hot Tamale"
3. Long shot of hot water heater	This is your hot water heater. It keeps a continuous supply of hot water available both day and night.
4. Hot water heater	The heating element operates under the control of a thermostat--factory regulated to provide you with sufficient hot water.
5. Hot water heater	Many times the thermostat is adjusted to provide water that is too hot for ordinary home use. The thermostat can be adjusted quite easily to provide a warmer or cooler water temperature. Most instruction booklets recommend that you contact your dealer or utility company.
6. Hot water heater	Time and energy can be saved by making this relatively-simple adjustment yourself.
7. Electrical outlet	It is very important that you first turn off the electrical supply to the water heater.
8. Screws	Remove the screws that hold both access panels.
9. Panels	Now remove the access panels.
10. Insulation	Note the presence of the fiberglass insulation.
11. Components	To expose the electrical components, fold the insulation aside and uncover the components behind the electrical barriers. Be sure to wash the fiberglass off your hands when you finish.
12. Thermostat	Now look for the thermostat. It will probably be adjusted to a temperature of approximately 150 .

13. Thermostat at 150	If hot water heaters provide water for bathing and showering only, the temperature can be much lower. Help conserve energy by reducing your hot water heater thermostat to 140 . The amount of hot water provided will still be adequate.
14. Thermostat at 140	To adjust the thermostat, take a small screw driver and turn the screw on both thermostat dials until the metal arrow attached to the screw points to 140 .
15. Finished product	Now you're set for saving energy and aiding in the conservation of our nation's energy resources.
16. Hot water heater	(Picture of the hot water heater being reassembled.)
17. Hot water heater	
18. The End	

RESOURCE LIST

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"Energy Conservation . . . Some Wheat, Some Chaff," American Gas Association Journal, V. 55, February 1973, p. 4.

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"The Campaign to Conserve Energy," American Gas Association Journal, V. 55, June 1973, p. 8.

"Thirty-one Fuel Crisis Responses for Adult Higher Education to Meet Consumer (Student) Needs," Adult Leadership, v. 23, June 1974, p. 53.

"Water and Energy," Reclamation Era, V. 61, Summer 1975, pp. 5-6.

Films

Nature's Forge (0497), 29 minutes, color, available from ERDA Film Library, Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

Nuclear Power and the Environment (0447), 14 minutes, color, available from ERDA Film Library, same as above.

The following films are available from Consumers Power Company, 212 W. Michigan Avenue, Jackson, Michigan 49201:

Big Dig (PR-109), 10 1/2 minutes

Challenge in the Air (PR-108), 28 minutes

Clean Town U.S.A. (PR-99), 13 1/2 minutes

Ee-Yi-Ee-Yi-Oh (PR-101), 10 1/2 minutes

Environment and Technology (FS-A), 25 minutes

Man and His Environment (FS-B), 28 minutes

Nation of Spoilers (PR-93), 11 minutes

Nuclear Power and the Environment (PR-86), 12 minutes

Rise and Fall of the Great Lakes (PR-95), 17 minutes

River That Came Back (PR-69), 28 minutes

Second Genesis (PR-98), 16 minutes

ENCORE

Chapter 6

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. define a list of vocabulary words related to energy conservation and consumption.
2. read the gauges of a watt-hour meter, given examples.
3. compute in KWH, the amount of electricity used, given examples of watt-hour readings.
4. determine the number of electrical appliances that use energy in the average home.
5. calculate how much money it costs to operate electrical appliances.
6. determine how much heat is given off by a light bulb.
7. determine how much light is given off by a light bulb.
8. determine how an electrical heating device works.

ENERGY CONSERVATION AND ELECTRICAL APPLIANCES

It took hundreds of millions of years to create the vast natural resources we are all carelessly wasting. How many times have you left an unused light burning or the television going when no one was around? Americans, who comprise only 6% of the earth's population, enjoy the highest standard of living in the world. In attaining this standard, we use approximately 1/3 of the energy used by the entire world.

Demands for fuel and energy are increasing daily and only a true nationwide effort to cut wasteful fuel usage will help to ease the future crisis. Why do we need to conserve our energy? The answer is simple--we must conserve our energy and resources today so we will have energy for the future. Also, we need to look for alternate forms of energy.

One way you can help is to become a "watts-watcher." You will be watching for wasted watts and thus become a wise consumer of energy. The old saying, "every little bit helps," applies to our watts-saving ways. In return, every bit saves you money and fuel.

Whether you mean to or not, you are a "watts-waster." Experts say that Americans waste at least 1/4 of the energy we use. The abundance of televisions, radios, and other electrical appliances that Americans think they must own, has led to wastefulness of electrical energy.

Electrical power is measured in watts. Each electric appliance uses a certain number of watts. For example, an iron uses an average of 1,008 watts. However, electrical energy is usually measured in kilowatt hours. "Kilo" means 1,000; therefore, a kilowatt is an easy way to say 1,000 watts. So, a kilowatt hour is 1,000 watts of electrical power used for one hour. If the electric iron were used for two hours, the power consumption would be 2 X 1,008 or 2,016 watt/hours or 2 kilowatt/hours.

A 100 watt light bulb will consume 1 kilowatt hour of energy every 10 hours. The same amount of energy would be necessary to lift a 150 pound person 17,700 feet in the air!

At our homes, we have a meter which does a very important job for us. It tells us how much electricity we are using. Thus, it serves as a measuring gauge. Your home's gauge or meter is call a "watt-meter" (see Figure VI-1). It gets its name from the fact that it measures electicity or how many kilowatt hours were used. The abbreviation for kilowatt hour is KWH. You can compare measuring electricity in KWH's to measuring gasoline in gallons.

To be a wise "watts-watcher" you must first be able to read your kilowatt-hour meter. Do you know what the watt-hour meter looks like? Do you know where the watt-hour meter is located at your home?

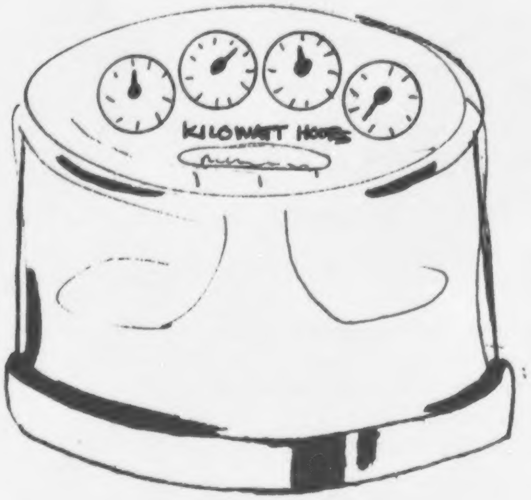
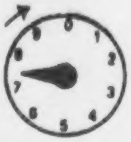


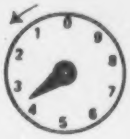
Figure VI-1

Note the dials on the watt-hour meter below. Reading the dials is not hard, but you must remembers three important things:

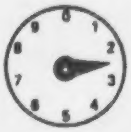
1. On some dials the numbers read clockwise like this:



While others read counterclockwise:

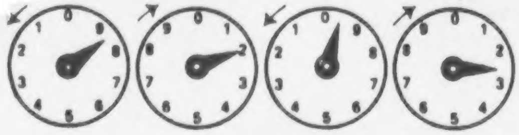


2. Read the lowest or smallest number. If the pointer is between two numbers, then take the smallest, not the closest.

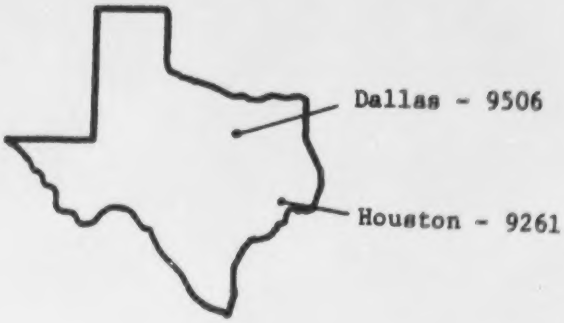


3. Write down the numbers in the order they appear (from left to right).

Now read the dials below.



Did you get 8192? If you did, then you read the meter dials correctly. The watt-hour meter works much like the mileage reader (the odometer) of a car. They both give a total reading. For example, if you were taking a trip to another town, you would read the mileage before you left and again when you arrived. To find out the number of miles you traveled, you would subtract the beginning mileage from the end mileage.

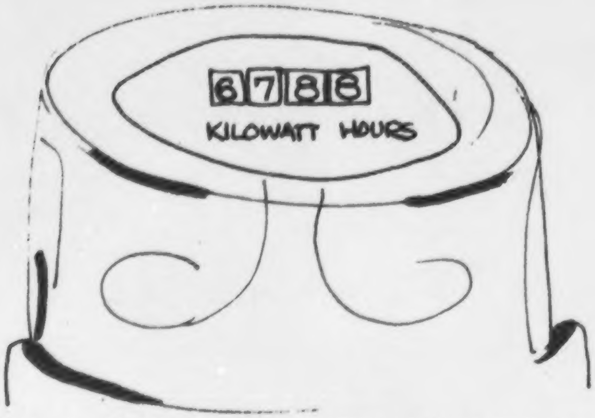


9506 - End mileage
-9261 - Beginning mileage
245 Total miles driven

In the same way, we can tell how much electricity we have used by taking a reading at the begining of a period of time and again at the end of that period. Then, subtract the first reading from the second reading. Here is a practice example. Monday morning the watt-hour meter read 4896. On Tuesday morning, the meter read 4918. Therefore, to find out the amount of electricity used in one day, subtract the first reading from the second.

4918 Kilowatt-hours on Tuesday
- 4896 Kilowatt-hours on Monday
22 Kilowatt-hours of electricity used.

There are various kinds of Kilowatt-hour meters. Many of you may have a digital type watt-hour meter. With this type you merely read the numbers from left to right as they appear on the meter. If the number is changing, always read the lower or smaller of the two. This type is shown on the following page.



On either the dial or digital type meters, there may be a rating of 10X. This means that the number of kilowatt hours shown must be multiplied by 10 to get the true reading of energy used. This is usually also indicated on your electricity bill. WHICH TYPE DO YOU HAVE? Now that you have learned how to read a kilowatt-hour meter, let us see how this information will be useful to you and your family in conserving energy. Can you think of ways that knowing how to read this meter will help you be a wiser consumer of electricity?

How Much Does It Cost To Operate Electrical Appliances?

Electrical appliances, devices and gadgets are owned and used by most Americans. We purchase these products to make our lives easier and more enjoyable. Americans think they have to own and use electrical appliances to do work for them. Because electricity is so easy to obtain, we tend to forget that it does cost us money. One way to help us to realize that electricity is not free, is to calculate how much money it actually costs to operate various appliances found in our home.

For example, the advertisement for a popular hair dryer claims "1000 watts of drying power." How much would it cost to dry your hair with this dryer if it takes 15 minutes to dry your hair? To determine this, we must first know how much electricity is used by the dryer. Electricity is sold by the kilowatt-hour. You should remember that a kilowatt-hour is equal to 1,000 watts of electrical power used for one hour, and it is abbreviated KWH. This particular hair dryer will use 1,000 watts of power for one-fourth of an hour (15 minutes). To convert watts to kilowatts, just move the decimal three places to the left. Thus, 1,000 watts is equal to 1 kilowatt. Next, to find the kilowatt-hours, it is necessary to multiply the number of kilowatts by the length of time (in hours) that it will be used. In our example, one kilowatt is to be used for one-fourth of an hour, so 1 KW X 1/4 hour = 1/4 KWH. It will require one-fourth of a KWH of electricity to dry your hair. How much does it cost to use one-fourth of a KWH? Generally, in Texas, electricity costs about five cents per KWH. You can find the exact cost per KWH in your area by dividing the total cost of your parent's last electric bill by the number of KWH used. Both appear on the electric bill. Let's assume for our example that electricity costs five cents per kilowatt hour. Thus, the cost to operate this hair dryer for 15 minutes is: .25 KWH X 5¢ = 1.25¢ or about 1 1/4 pennies.

Summary of steps to calculate electrical cost

1. Find how many watts the appliance is rated at from either the "Appliances--Annual KWH Per Year" list, data plate of the appliance, the owner's manual or a catalog.
2. Convert watts to kilowatts by moving the decimal three places to the left.
3. Calculate KWH by multiplying the number of KW found in step 2 by the amount of time (in hours) the appliance will be in use.
4. Calculate cost by multiplying KWH by the cost per KWH.

APPLIANCES--ANNUAL KWH PER YEAR

APPLIANCE	AVERAGE WATTAGE	ANNUAL KWH CONSUMPTION
water heater (quick recovery)	4,474	4,811
water heater (standard)	2,475	4,219
refrigerator/freezer, frostless (14 cu. ft.)	615	1,829
freezer, frostless (15 cu. ft.)	440	1,761
air conditioner	1,566	1,389
range (self-cleaning)	12,200	1,205
freezer (15 cu. ft.)	341	1,195
range	12,200	1,175
oven (self-cleaning)	4,800	1,146
refrigerator/freezer (14 cu. ft.)	326	1,137
clothes dryer	4,856	993
television, color (tube type)	300	660
television, color (partial solid state)	200	440
dishwasher	1,301	363
television, black & white (tube type)	160	350
oven (microwave)	1,500	300
air cleaner	50	216
frying pan	1,196	186
heater (portable)	1,322	176
fan (window)	200	170
iron (hand)	1,008	144
television, black & white (solid state)	55	120
radio/record player	109	109
coffee maker	894	106

APPLIANCE	AVERAGE WATTAGE	ANNUAL KWH CONSUMPTION
broiler	1,436	100
radio	71	86
deep fryer	1,448	83
washing machine (manual)	286	76
trash compactor	400	50
vacuum cleaner	630	46
fan (circulating)	88	43
toaster	1,146	39
waste disposal	445	30
clock	2	17
sun lamp	279	16
blender	386	15
hair dryer	381	14
heater (infrared)	250	13
mixer	127	13
sewing machine	75	11
carving knife	92	8
shaver	14	1.8
toothbrush	7	0.5

ACTIVITIES

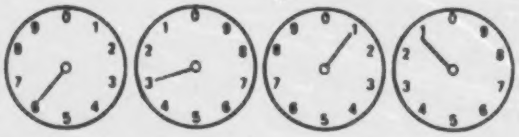
1. Practice reading the watt-hour meter gauge (Activity VI-1).
2. Keep a record of the watt-hour meter readings at your home for a week. Find out your daily average consumption, total weekly consumtion and the average amount of energy used by each member of your family for one week (Activity VI-2).
3. Make a bar graph of your findings in the homework activity above (Activity VI-3).
4. Have a scavenger hunt in your own home and see how many electrical appliances there are in your house. Try to guess which five appliances use the most energy. Take a class talley (Activity VI-4).
5. Complete the "Find-a-Word" puzzle (Activity VI-5).
6. Complete the "Energy Conservation Crossword Puzzle" (Activity VI-6).
7. Complete the two worksheets that show you how to calculate how much money is spent when using electrical appliances (Activity VI-7).
8. Determine how much heat is given off by a light bulb (Activity VI-8).
9. Determine how much light is given off by a light bulb (Activity VI-9).
10. Determine how an electrical heating device works (Activity VI-10).
11. View the transparencies on "Energy Can Be Conserved" (Activity VI-11).
12. View the slide presentation on "Watts Watching" (Activity VI-12).
13. Define the vocabulary words (Activity VI-13).

Reading the Watt-Hour Meter Gauge

(Activity VI-1)

Read the dials and write the correct numbers on the blanks provided.

1



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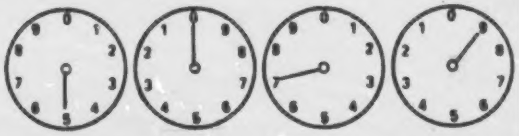

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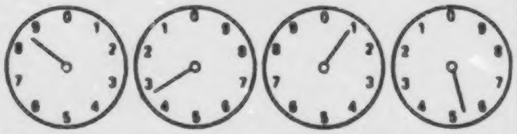

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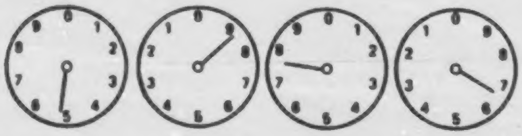

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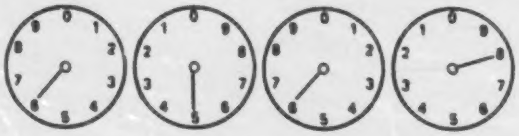

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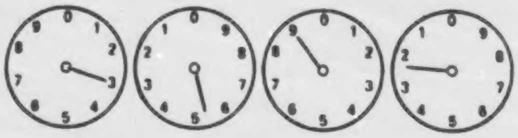

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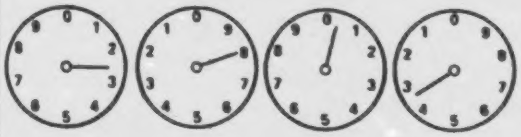

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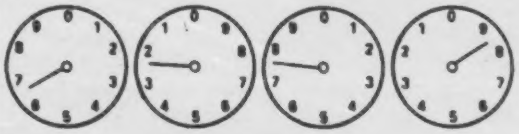

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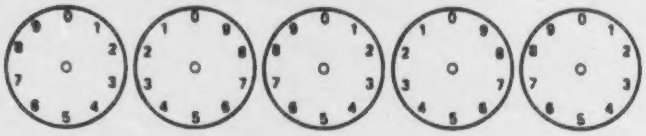
Meter Reading Record

(Activity VI-2)

1. Take this sheet home and keep it in a safe place. Your daily readings will be recorded on the spaces provided.
2. Be sure to make the reading at the same time each day.
3. Draw the positions of the hands of the meter on the dials below.
4. Write the number in the space below each dial.
5. If your meter does not have dials, just put the number under each drawing.
6. If your meter has only 4 dials, do not use the last one.

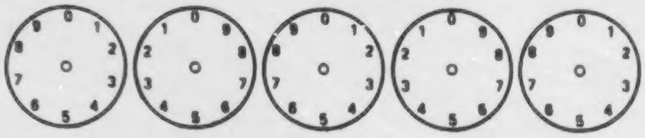
DAY 1


9 0 1 2 3 4 5 6 7 8
1 0 9 8 7 6 5 4 3 2
9 0 1 2 3 4 5 6 7 8
1 0 9 8 7 6 5 4 3 2
9 0 1 2 3 4 5 6 7 8

____ ____ ____ ____ ____

Meter Reading Day 1 ______________

DAY 2


9 0 1 2 3 4 5 6 7 8
1 0 9 8 7 6 5 4 3 2
9 0 1 2 3 4 5 6 7 8
1 0 9 8 7 6 5 4 3 2
9 0 1 2 3 4 5 6 7 8

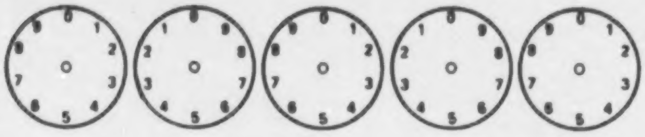
____ ____ ____ ____ ____

Reading Day 2 ______________

Reading Day 1 ______________

KWH used ______________

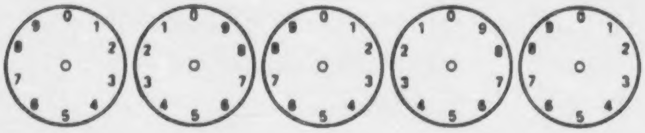
DAY 3



____ ____ ____ ____ ____

Reading Day 3____________________
Reading Day 2____________________
KWH used ____________________

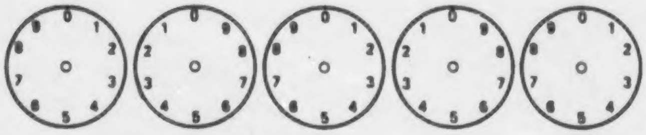
DAY 4



____ ____ ____ ____ ____

Reading Day 4____________________
Reading Day 3____________________
KWH used ____________________

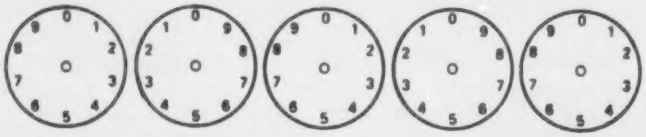
DAY 5



____ ____ ____ ____ ____

Reading Day 5____________________
Reading Day 4____________________
KWH used ____________________

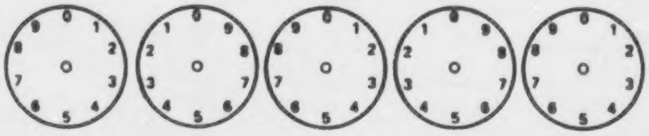
DAY 6



____ ____ ____ ____ ____

Reading Day 6____________________
Reading Day 5____________________
KWH used ____________________

DAY 7



____ ____ ____ ____ ____

Reading Day 7____________________
Reading Day 6____________________
KWH used ____________________

Now, calculate the amount of energy you and your family consumed in one week.

____
Reading on Day 7

minus

____
Reading on Day 1

equals

____
Total Weekly Use

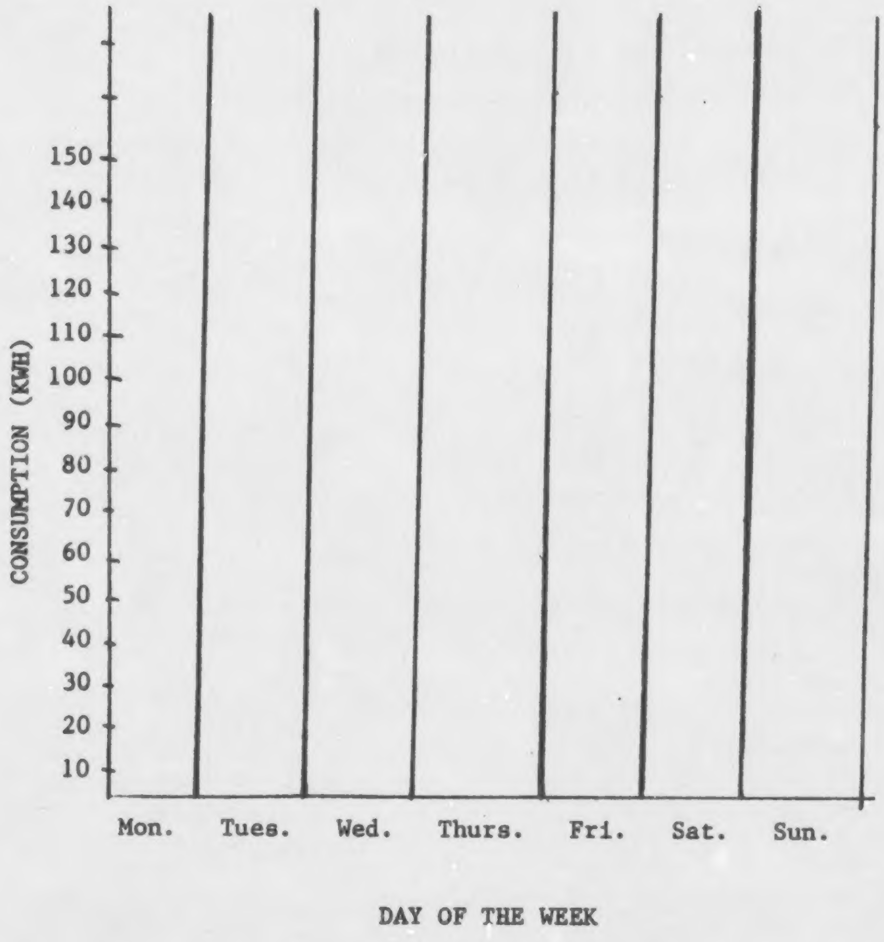
Now you are ready to calculate how much energy each person living in your house used on an average. To find this, divide the number of people who live in your house into the total number of KWH used in the seven day period.

Graph of Electrical Energy Consumption

(Activity VI-3)

You have followed the energy used by your family in the form of electricity for a period of one week. Follow the directions given and make a bar graph showing your consumption.

1. Take the results of your daily home consumption. This information is found on your homework chart.
2. Make a bar graph. Color in the amount for each day.
3. Use the graph below to show your consumption.



Home Scavenger Hunt

(Activity VI-4)

It may surprise you to discover that you have so many appliances and such which require electricity. Place a check beside each of the following which you have in your home. Please add those which are not listed.

Major Electrical Appliances

______ Clothes dryer
______ Clothes washer
______ Dishwasher
______ Food Freezer
______ Food waste disposal
______ Ice Cube Maker
______ Range (Stove)
______ Refrigerator
______ Trash Compactor
______ Water Heater
______
______

Electric Housekeeping Appliances

______ Floor Polisher
______ Floor Scrubber
______ Iron
______ Rug Shampooer
______ Vacuum cleaner
______ Water softener
______

Electric Appliances for Hobbies, Amusement, Recreation, Do-It-Yourself

______ Adding machine
______ Aquarium filter and heater
______ Barbeque
______ Battery charger
______ Calculator
______ Charcoal lighter
______ Dog clippers
______ Eraser
______ Fireplace logs
______ Movie projector
______ Organ
______ Pencil Sharpener
______ Piano
______ Photo enlarger
______ Power tools
______ Radio
______ Sewing machine
______ Scissors
______ Slide projector
______ Soldering iron
______ Stereo/tape player
______ Swimming Pool Filter
______ Tape recorder
______ Television
______ Toys
______ Typewriter.

Electric Houseware

______ Baby food warmer
______ Bean pot or slow cooker
______ Blender
______ Bottle warmer
______ Broiler-Toaster Oven
______ Can opener
______ Carving knife
______ Chafing dish
______ Coffee maker
______ Corn popper
______ Deep fat fryer
______ Dutch oven
______ Fondue pot
______ Food mixer or grinder
______ Griddle
______ Hot plate
______ Ice cream freezer
______ Ice crusher
______ Juice extractor
______ Knife
______ Microwave oven
______ Rotisserie oven
______ Sharpener
______ Skillet
______ Sterilizer
______ Toaster
______ Waffle Iron
______ Warming Tray
______ Yogurt maker
______

Electric Appliances Providing Personal Comfort, Convenience, Hygiene and Appearance

______ Air conditioner (central)
______ Air purifier (window)
______ Blanket
______ Clock
______ Clother Brush
______ Curling Iron
______ Curlers
______ Dehumidifier
______ Electrostatic air cleaner
______ Evaporative cooler
______ Exerciser
______ Fans, attic
______ Fans, circulating
______ Fans, kitchen exhaust
______ Foot and back massager
______ Garage Door Opener
______ Hair clippers
______ Heat lamp
______ Hot comb
______ Hot lather dispenser
______ Heating, and blower
______ Humidifier
______ Lighted mirror
______ Manicure set
______ Range hoodlight and fan
______ Shaver
______ Reducing Machine
______ Shoe polisher
______ Sun lamp
______ Toothbrush
______ Vaporizer
______ Water pic
______ Whirlpool bath

Light bulbs

______ 60 Watts
______ 75 Watts
______ 100 Watts
______ 150 Watts
______ ____ Watts
______ ____ Watts

Don't forget the light in the refrigerator!

Go back and very carefully put a circle around the 5 things which you feel use the most electricity. Take a class tally, see who was closest by comparing it to chart of Appliances-Annual KWHR/Year.

Find-a-Word Puzzle

(Activity VI-5)

Try to find the words (which are listed by the side of the puzzle) in the puzzle below. When you find a word, put a circle around it and mark the word off the list so you will know when you have found them all. Answer the two questions at the bottom of the page.

```
C N Q X R Q D B R O I L E R T F V M Z C G
M I X E R W L N G T Q S D P R W S O P J H
Z S S R F E Q T P V P F G N V C X T T Z W
S M K M N Q F R J O E R E T S C D O H Z A
C R P D L A K R J G N T R D M N N R D H S
L H E M N O I S I V E L E T T S L C J M H
T R N F L V J M V G G D S N M F L Y P K I
L L N R P M K X L F E F W D M K C C Q G N
S Q P E L E C T R I C R A N G E F L R W G
E C T E H S W H G Q X R A C Q Z K E R G M
W K P Z D L F L R J K H D T X C G R J S A
I H G E V S H W K J K X Z P O V E N Z P C
N Y N R K X M J X M J J L L K R A D I O H
G T F K R C V A C U U M C L E A N E R A I
M R L I G H T S V Q J H W J H T N H R I N
A L S A J T V G M V N W H N D X K P X R E
C J L C W A T E R H E A T E R Z F C G C Q
H D D K F N G F H Q W R X S Y G Z H Z O D
I A P K N M M L K H D R W J E G P L C N C
N R I M N H T O A S T E R G R A T Z R D F
E P L R R X G S W S T M C F R V M E F I N
V D F T D H L N J E D G P G X N H W D T X
K V L P M R N D G M R L D Z K S Q W V I P
K Q S R C S Y N W T F N X V A W F X P O Z
W N Z D P X A E Q Y O R G W S C T Z V N C
M J F H I R O N R H V G H H Z R J Z K E X
C R J P S R Q H P N G S D M D Q S L D R C
L S D A U T O M O B I L E Z F T X C Z V W
T K G C J G V H C D G T F S T D R W V C Q
```

Things Around the Home
That Use Energy

air conditioner, automobile, blender, broiler, clock, dishwasher, dryer, edger, electric range, freezer, gas range, hair dryer, iron, lawn mower, lights, mixer, motorcycle, oven, phonograph, radio, refrigerator, sewing machine, stereo, television, toaster, vacuum cleaner, washing machine, water heater, and fan

What energy using devices are around your home that were not around your grandparents' home? Your great-grandparents' home?

Energy Conservation Crossword Puzzle

(Activity VI-6)

ACROSS

4. If everyone cut down his energy use, the _____________savings would be great.

5. Gasoline _______is one way of meeting the energy crunch.

9. The United States is currently experiencing a _____of energy supplies.

11. _____ the water level in your washer according to the size load you have.

12. The frost _____ refrigerator costs 1 1/2 times as much to operate as the refrigerator you must defrost yourself.

14. _____around windows to keep warm air inside and cold air out.

15. _____ provides only a tiny part of our energy needs.

18. Stuff rolled-up _____ in cracks around doors and windows to keep cold air out.

20. To keep feet warmer, put on an extra pair of _____.

21. The United States has less than 6 percent of the world's _____but almost half its cars.

23. _____ film can be used as a temporary storm window.

30. More than a quarter of the U.S. energy budget goes for _____.

31. _____ the frost from your refrigerator allows it to operate more efficiently.

32. Clean or _____ your furnace filter regularly.

34. _____ fission is a minor source of energy today.

35. Demand for energy has _____ at a startling rate.

37. If you aren't using a _____ in your house, close it off.

38. We cannot stand by and do _____ about the energy shortage.

39. For better gas mileage, keep your _____ inflated properly.

42. When you _____ clothes, avoid overdrying; it sets wrinkles and wastes energy.

43. Cutting energy _____ is a big part of coping with energy crisis.

44. Using more _____ cubes than you need wastes energy.

45. Clean or change your furnace _____ regularly.

46. Energy-saving measures can become thrifty _____ that will save us money.

47. Reducing your _____ from 70 to 50 can improve your car's mileage.

48. _____ is the most energy-efficient means of transportation.

50. In the generation of electricity, energy is lost in the form of waste _____.

51. Whenever possible, _____ pans to eliminate heat loss while cooking.

55. The United States uses _____ energy than any other nation.

57. An uninsulated house _____ a great deal of heat through the roof.

58. The United States has almost half the world's _____.

59. Turn off the _____ in a room when no one is using them.

60. Most of the energy resources we rely on are _____.

61. Electricity is measured in _____.

63. Windmills take advantage of wind _____.

65. Two free sources of energy are sun and _____.

68. Every family makes _____ of energy-use decisions every day.

69. _____ around doors and windows can cut heat loss.

71. Cutting our energy budget will not require any _____ changes in lifestyle.

73. Ceiling _____ can greatly reduce heat loss through the roof.

74. Driving slower should reduce your car's gas _____.

76. Avoid letting the hot water _____ needlessly.

77. Consumers need to make energy-related decisions _____.

78. Recycling and _____ things you'd normally throw away helps save energy.

79. _____ light cars get more miles per gallon than big, heavy cars.

DOWN

1. When you use your range _____, fill it up.

2. Cars consume billions of gallons of _____ every year.

3. Gasoline, kerosene, diesel fuel and host of other products are derived from _____.

6. Many Michigan homes are heated with natural _____.

7. _____ is our major fuel resource.

8. Saving energy saves _____.

10. Fossil fuel is no longer the _____ commodity it once was.

12. The refrigerator that keeps itself free of _____ costs 1 1/2 times as much to operate as the refrigerator you must defrost yourself.

13. Opening cans by hand will not save a lot of _____.

14. _____ provides for about 18 percent of our energy needs.

15. In the home a good deal of energy is used for _____

16. If reducing the temperature in your home has left you cold, put on a _____.

17. Open your ____ when the sun shines to take advantage of the sun's energy for heating.

19. The largest part of the home energy budget goes for heating _____.

22. You can reduce the amount of driving you do by _____ your route better.

24. Your efforts _____ make a difference!

25. Energy demands from the _____ sector make up almost 1/5 of the national energy budget.

26. Turn off electric _____ when not in use.

27. "Power" accessories and extras cut your car's _____ per gallon.

28. More energy is consumed in the _____ sector of society than in any other.

29. The energy crisis is sure to affect the way we use our _____ time.

30. Cut home heating costs by lowering the _____ to 68 degrees.

33. Only _____ are less energy-efficient than automobiles.

36. We must try for more _____ energy use.

40. _____ is what this puzzle is all about.

41. To reduce peak energy use in early evening, the whole nation went on __________ saving time.

42. Avoid opening the refrigerator _____ more than necessary.

48. Turn the heat _____ 70 degrees to save energy.

49. Energy _____ have risen phenomenally in past months.

51. Increasing the humidity in your home will add to your _____ but will not necessarily allow you to get by with less fuel.

52. _____ is not a major source of energy.

53. A tiny _____ can waste hundreds of gallons of hot water in a year.

54. Organize a _____ _____ (two words) to reduce gas consumption by cutting the number of cars on the road.

56. The instant-on _____ is on even when it is off.

62. A change in consumer _____ is necessary to make energy conservation work.

64. The cost of energy has to _____.

65. Much heat is lost through _____.

66. _____ windows cut heat loss.

67. Cut _____, not out, to save energy.

69. Wear more clothes to keep _____.

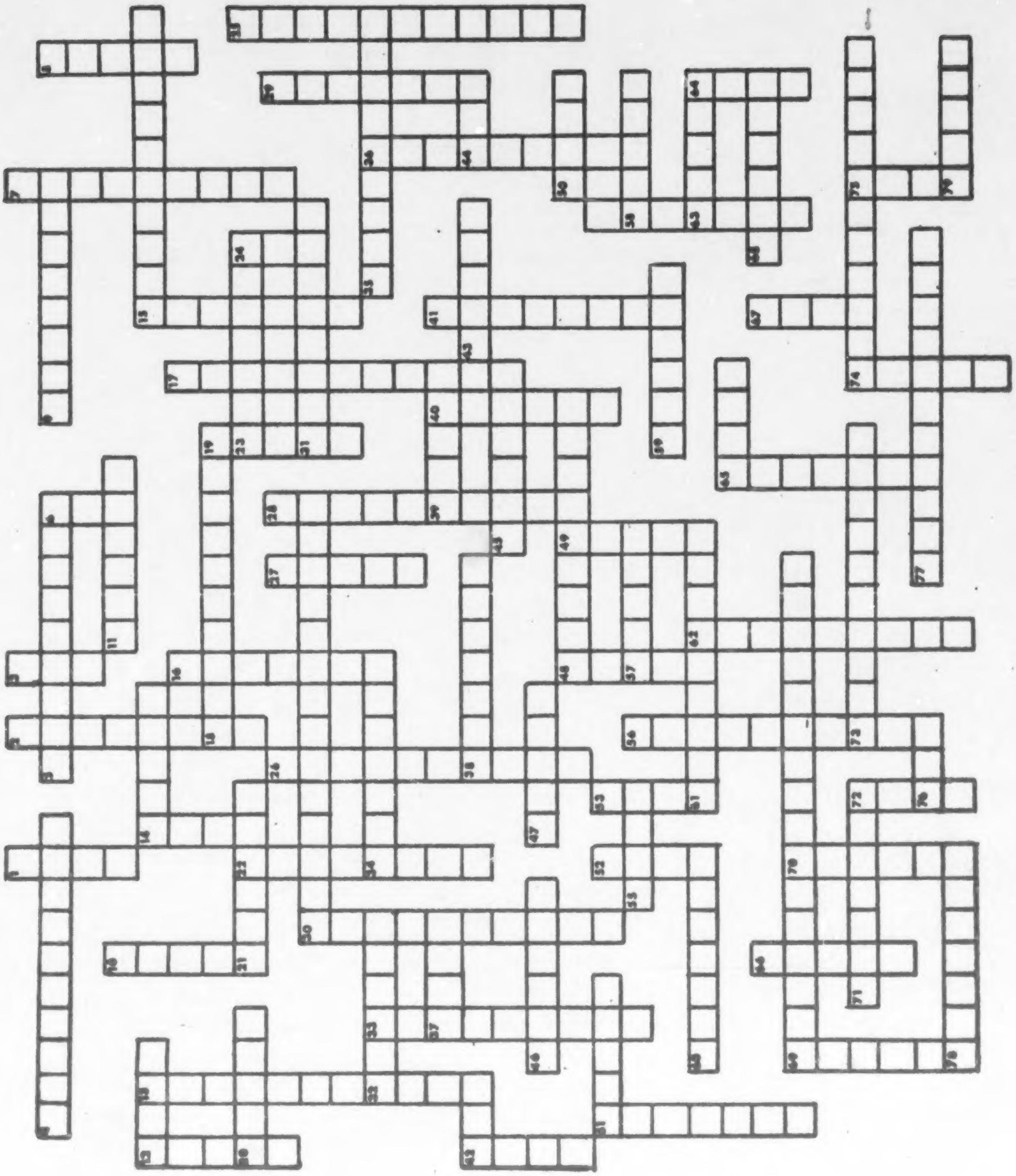
70. You can use the data on the back of an air conditioner to figure its efficiency ______.

72. No quick _____ for the energy shortage is in sight.

74. _____ the fireplace damper when the fireplace is not in use.

75. Use _____ and pans that fit stove burners.

Prepared by: Leslie McConkey
Extension Family Living
Education



The Cost of Operating Electrical Devices

(Activity VI-7)

1. A slide projector uses a 400 watt lamp. How much will it cost to operate the projector for one hour if electricity costs 4¢ per kilowatt hour?

2. A stereo system draws 250 watts of power. How much would it cost to operate the stereo for 4 hours if electricity costs 4¢ per kilowatt hour?

3. An electric typewriter needs 0.5 amps to operate on a 110 volt line. How much will it cost to type for 2 hours if electricity costs 5¢ per kilowatt hour?

4. A battery charger uses 150 watts. How much would it cost to charge up a battery if it took 2 hours to charge it and electricity costs 6¢ per kilowatt hour?

5. An automatic garage door opener draws 6 amps on a 110 volt line. How much does it cost to operate if it is operated a total of two hours during the year and electricity costs 5¢ per kilowatt hour?

6. How much does it cost to burn a 100 watt light bulb for 24 hours if electricity costs five cents per kwh?

The Cost of Operating Electrical Devices

(Activity VI-7)

1. An electric range needs 7 kilowatts to operate. How much does it cost to cook a meat loaf if the cooking time is 1 hour and the cost of electricity is 6¢ per kilowatt hour?

2. An electric clock draws 0.1 amps on a 110 volt line. How much does it cost to operate the clock all year if the cost of electricity is 4¢ per kilowatt hour?

3. A color television draws 150 watts on a 110 volt line. How much does it cost to watch television for 4 hours if electricity costs 5¢ per kilowatt hour?

4. A black and white television draws 68 watts. How much cheaper would it be compared to the color television and how much energy would you save by watching it for 4 hours if electricity costs 5¢ per kilowatt hour?

5. How much would it cost to play an electric organ for 2 hours if the organ used 60 watts and electricity costs 6¢ per kilowatt hour?

6. Which uses the most electrical energy: a 1500 watt TV watched for 4 hours or ten 100 watt light bulbs burning for 5 hours?

How Much Heat is Given Off by a Light Bulb?

(Activity VI-8)

Purpose

To show that light bulbs not only give us light but also give off unwanted heat, which means the light bulb is having to use extra energy to make the unwanted heat.

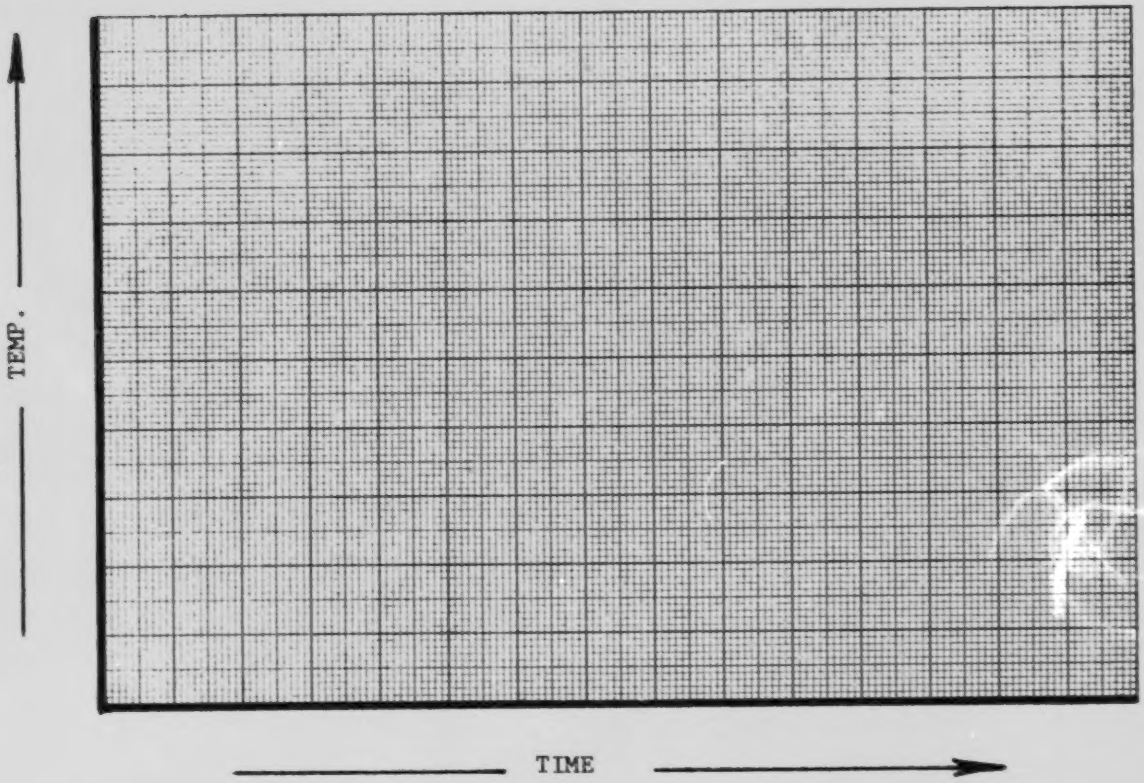
Materials

25 watt bulb
60 watt bulb
100 watt bulb
bulb socket
thermometer
jar
water

Procedure

Put some water in the jar and lower the thermometer into the water. Be sure the thermometer is not touching the glass jar. Place a lighted 25 watt bulb near the jar but not touching it. Read and record the temperature of the water. Take temperature readings at regular intervals (3-5 minutes) until the temperature becomes constant. With the same amount of water, repeat the procedure with the other sizes of light bulbs, making sure that the glass, thermometer, and water have cooled to room temperature again.

Data:	25 watt bulb	60 watt bulb	100 watt bulb
TIME:	TEMPERATURE	TEMPERATURE	TEMPERATURE



Questions

1. Which bulb gave off the most heat? ______________________

2. If you are trying to cool your house, how can you save cooling energy with your lights?

   ____

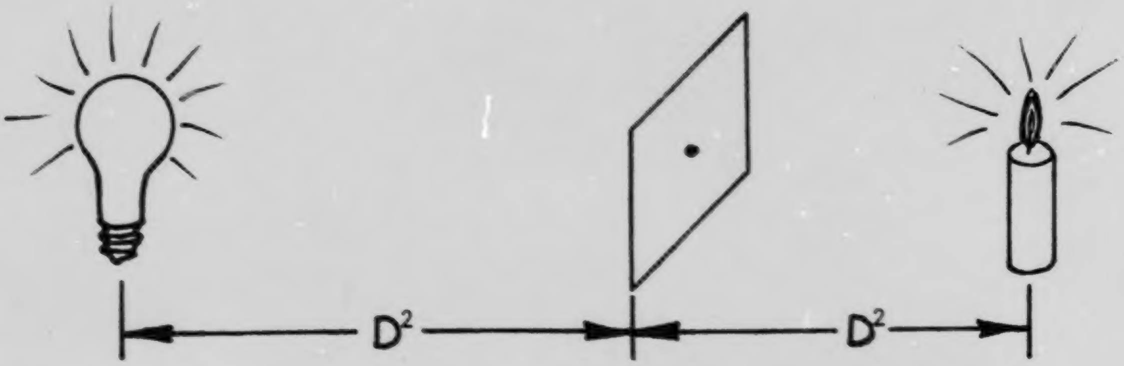
   ____

   ____

   ____

Activity VI-9 is meant to show that not all light bulbs give off the same amount of light for each watt of power used. If a light meter is not available, you might try a filter paper photometer. This is made by allowing a drop of candle wax to fall on the center of a piece of filter paper, mimeograph paper or typing paper, or any non-shiny paper. After the wax has dried, scrape it off with your fingernail. This will leave a spot that transmits light but reflects it very poorly. The paper is then held between a candle and another light source at such a distance between the two that the spot on the paper appears to have the same intensity from both light sources. The intensity of the light from the source will be expressed in candles (sometimes called candlepower). The intensity of the source will be the ratio of the square of the distances involved.

$$\text{Intensity of light} = \frac{\text{Square of distance, light to paper}}{\text{Square of distance, candle to paper}}$$



How Much Light is Given Off by a Light Bulb?

(Activity VI-9)

Purpose

To show that not all light bulbs give off the same amount of light for each watt of power used.

Materials

25 watt bulb	light socket
60 watt bulb	light meter
100 watt bulb	

Procedure

Place the light meter the same distance from each bulb and record the reading.

Data

Size of Bulb	Reading	Light Units/Watt
25 watt		
60 watt		
100 watt		

Note: To find light units/watt, divide the light meter reading by the wattage of the bulb.

Questions

1. Which bulb gave off the most light? ____________________
2. Which bulb gave off the most light/watt? ________________
3. How can you save energy and still get the light you need?

____

____

____

Vocabulary

(Activity VI-13)

1. conservation -
2. deuterium -
3. efficiency -
4. hydrogen -
5. kilowatt -
6. kilowatt hour (KWH) -
7. research -
8. resources -
9. shortage -
10. thermal -
11. watt -
12. watt-meter -

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide information on energy conservation related primarily to household electrical appliances.

There are thirteen activities provided to insure understanding of the basic concepts related to the metering of electricity and the wastefulness of unnecessary electrical appliances. Make sure the students read the information section before attempting the activities. Most of the activities are relatively simple and individualized. The crossword puzzle has been used as a group project and as an extra credit activity because of the level of difficulty. The three experiments are fairly simple and the results vary. Concentrate on the concepts and purposes of the experiment, not the exact results. The transparencies are a fast, general review of conservation. The slide presentation is a more specific review of the chapter. The vocabulary list may be helpful in fostering comprehension.

List of Materials

Activity VI-1

hand-out of watts-meter dials and pen or pencil

Activity VI-2

hand-out of weekly watts-meter record, watts-meter and pen or pencil

Activity VI-3

results of Activity VI-2, hand-out of bar graph and pen or pencil

Activity VI-4

hand-out of Household Appliances Check List and pen or pencil

Activity VI-5

hand-out of Find-A-Word Puzzle and pen or pencil

Activity VI-6

hand-out of Energy Conservation Crossword Puzzle and pen or pencil

Activity VI-7

hand-out of The Cost of Operating Electrical Devices and pen or pencil

Activity VI-8

one 25, 60 and 100 watt light bulbs, bulb socket, thermometer, jar and water

Activity VI-9

one 25, 60, and 100 watt light bulbs, light socket, and light meter

Activity VI-10

1.5 v dry cell, candle wax, a switch, and two pieces of uninsulated copper wire of different diameters

Activity VI-11

"Energy Can Be Conserved" transparencies

Activity VI-12

slides, slide script, and slide projector

Activity VI-13

hand-out of vocabulary words and pen or pencil

TEST

1. Which of the following is not a problem associated with the use of energy?

   A. environmental pollution

   * B. unemployment

   C. depletion of fuel reserves

   D. political and economic effects

2. Mid-eastern nations have considerable economic and political power because they have a

   A. strong sheik

   B. great army

   * C. large supply of fuel

   D. reputation for honesty

3. The population of the United States is approximately 6% of the earth's population, and Americans use approximately ______ of the energy used by the entire world.

   A. 10%

   * B. 33%

   C. 65%

   D. 90%

4. The abbreviation for kilowatt hour is

   A. Kh

   * B. KWH

   C. KW

   D. KH

5. According to the experts, how much of the energy that is used by Americans is considered to be wasted?

   * A. 25%

   B. 50%

   C. 75%

   D. 100%

6. Electrical energy is measured in

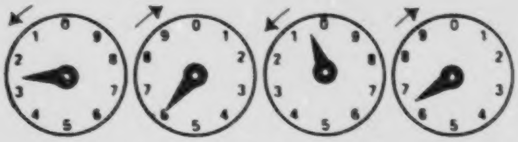
A. man-hours

C. sparks per second

B. miles per gallon

* D. kilowatt-hours

7. The following gauge dials read



A. 2617

* C. 2606

B. 3763

D. 3658

8. A certain toaster is rated at 1250 watts. How many kilowatts is this equivalent to?

A. .1250

C. 12.50

* B. 1.250

D. 125.0

9. If electricity cost 6¢ per kilowatt-hour, how much would it cost to heat a room for two hours with a 2000 watt electric heater?

A. $120.00

C. $1.20

B. $12.00

* D. $ .12

10. Which of the following appliances would probably use the greatest a amount of electrical energy?

* A. air conditioner

C. tape recorder

B. can opener

D. vacuum cleaner

11. The nation that has the highest standard of living in the world is

A. Japan

* C. United States

B. Canada

D. Russia

12. The instrument that is used to measure the amount of electricity used is called a

* A. watt-hour meter

C. ammeter

B. volt meter

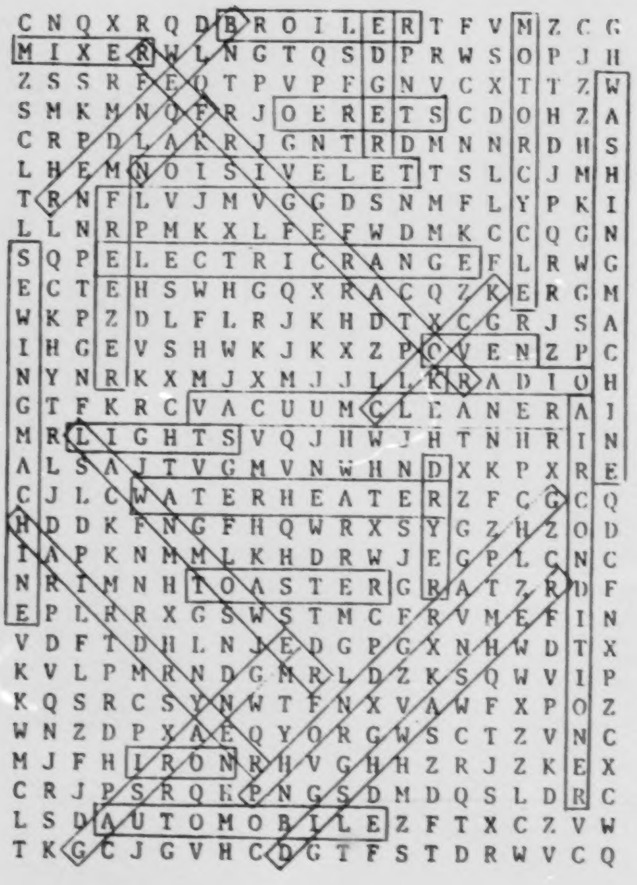
D. multi-meter

Answers: Activity VI-1

1. 6311 KWH
2. 5079 KWH
3. 8305 KWH
4. 5876 KWH
5. 6568 KWH
6. 3592 KWH
7. 2803 KWH
8. 6278 KWH

Find-a-Word Puzzle Key

(Activity VI-5)



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C N Q X R Q D B R O I L E R T F V M Z C G
M I X E R W L N G T Q S D P R W S O P J H
Z S S R F E Q T P V P F G N V C X T T Z W
S M K M N Q F R J O E R E T S C D O H Z A
C R P D L A K R J G N T R D M N N R D H S
L H E M N O I S I V E L E T T S L C J M H
T R N F L V J M V G G D S N M F L Y P K I
L L N R P M K X L F E F W D M K C C Q G N
S Q P E L E C T R I C R A N G E F L R W G
E C T E H S W H G Q X R A C Q Z K E R G M
W K P Z D L F L R J K H D T X C G R J S A
I H G E V S H W K J K X Z P O V E N Z P C
N Y N R K X M J X M J J L L K R A D I O H
G T F K R C V A C U U M C L E A N E R A J
M R L I G H T S V Q J H W J H T N H R I N
A L S A J T V G M V N W H N D X K P X R E
C J L C W A T E R H E A T E R Z F C G C Q
H D D K F N G F H Q W R X S Y G Z H Z O D
I A P K N M M L K H D R W J E G P L C N C
N R I M N H T O A S T E R G R A T Z R D F
E P L R R X G S W S T M C F R V M E F I N
V D F T D H L N J E D G P G X N H W D T X
K V L P M R N D G M R L D Z K S Q W V I P
K Q S R C S Y N W T F N X V A W F X P O Z
W N Z D P X A E Q Y O R G W S C T Z V N C
M J F H I R O N R H V G H H Z R J Z K E X
C R J P S R Q K P N G S D M D Q S L D R C
L S D A U T O M O B I L E Z F T X C Z V W
T K G C J G V H C D G T F S T D R W V C Q
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Answers: Energy Conservation Crossword Puzzle

(Activity VI-6)

ACROSS

4. collective
5. rationing
9. shortage
11. adjust
12. free
14. caulk
15. hydropower
18. newspapers
20. socks
21. people
23. plastic
30. transportation
31. cleaning
32. change
34. nuclear
35. increased
37. room
38. nothing
39. tires
42. dry
44. ice
45. filter
46. habits
47. speed
48. bicycling
50. heat
51. cover
55. more
57. loses
58. autos
59. lights
60. limited
61. kilowatts
63. power
65. wind
68. dozens
69. weatherstripping
71. drastic
73. insulation
74. consumption
76. run
77. consciously
78. reusing
79. small

DOWN

1. oven
2. gasoline
3. oil
6. gas
7. petroleum
8. money
10. cheap
12. frost
13. electricity
14. coal
15. heating
16. sweater
17. draperies
19. space
22. planning
24. can
25. residential
26. appliances
27. miles
28. industrial
29. leisure
30. thermostat
33. airplanes
36. efficient
40. energy
41. daylight
42. door
48. below
49. costs
51. comfort
52. wood
53. leak
54. carpool
56. television
62. attitudes
64. rise
65. windows
66. storm
67. down
69. warmer
70. rating
72. cure
74. close
75. pots

Answer Key

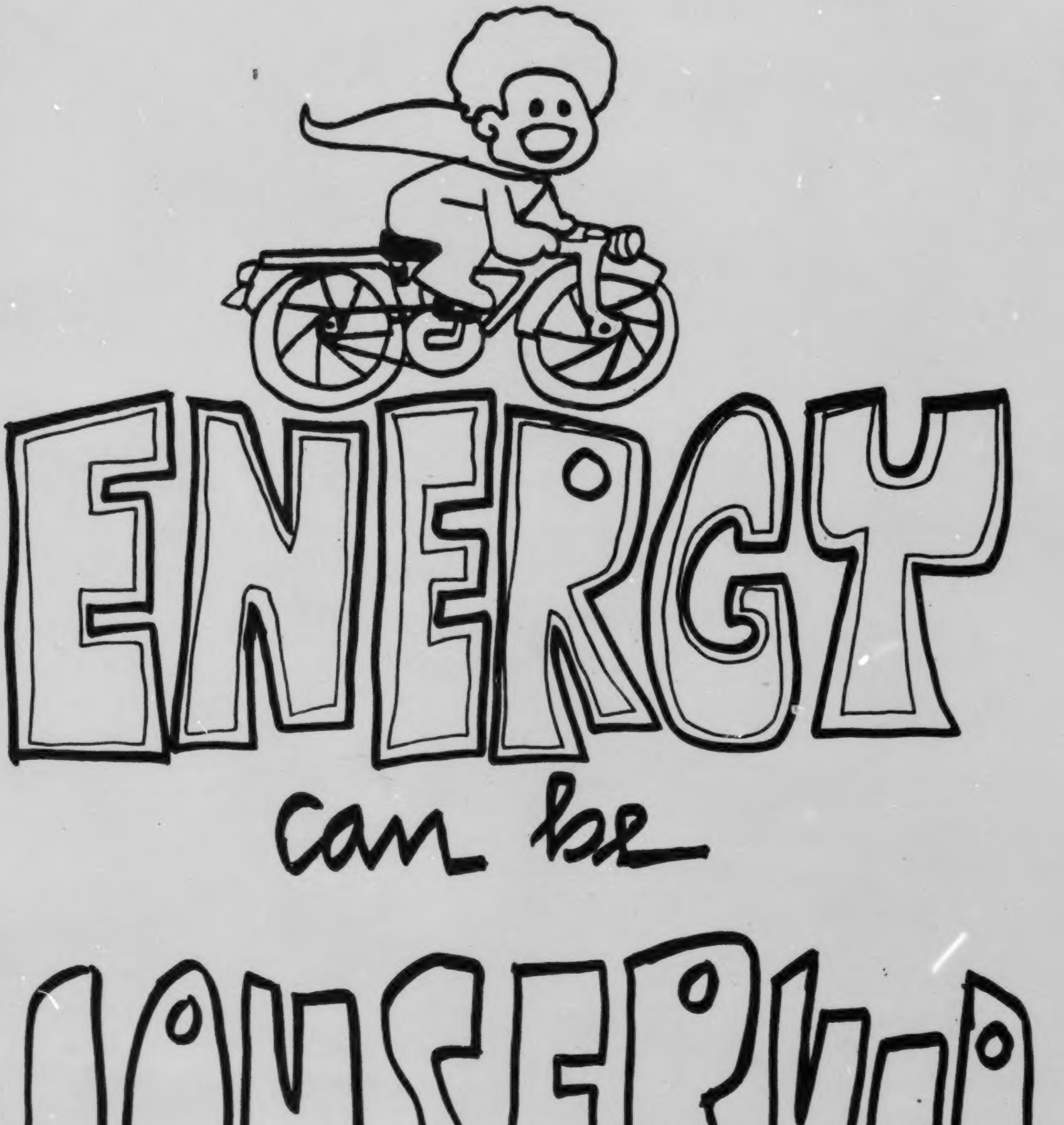
(Activity VI-7)

Worksheet #1

1. .016¢
2. 4¢
3. 5.5¢
4. 1.8¢
5. 6.6¢
6. 12¢

Worksheet #2

1. 42¢
2. $3.68
3. 30¢
4. 16.4¢ cheaper
5. .007¢
6. the television uses the most electrical energy


ENERGY
can be
CONSERVED

(National Science Teachers Association,
Energy-Environment Mini-Unit Guide, 1975)

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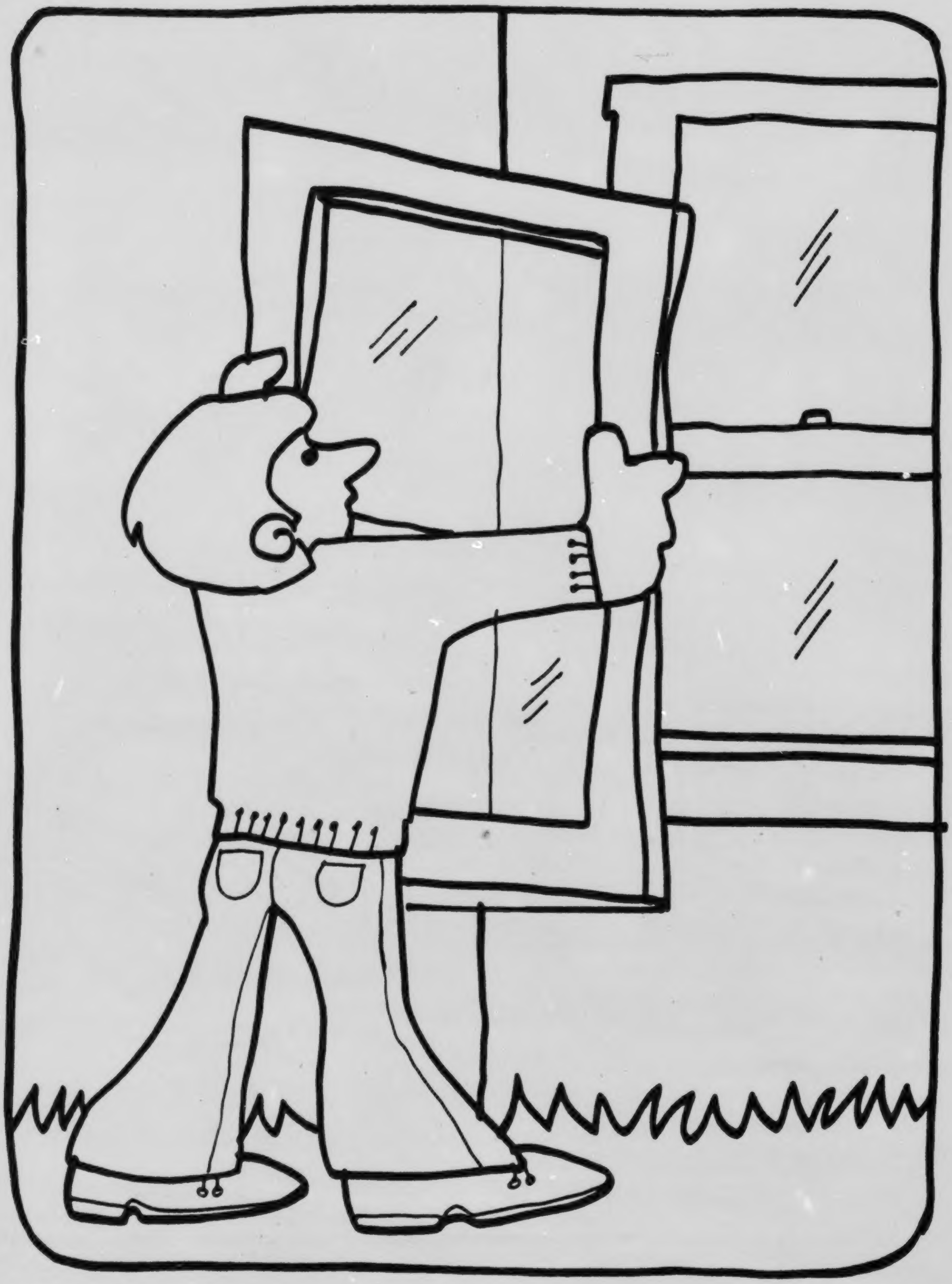

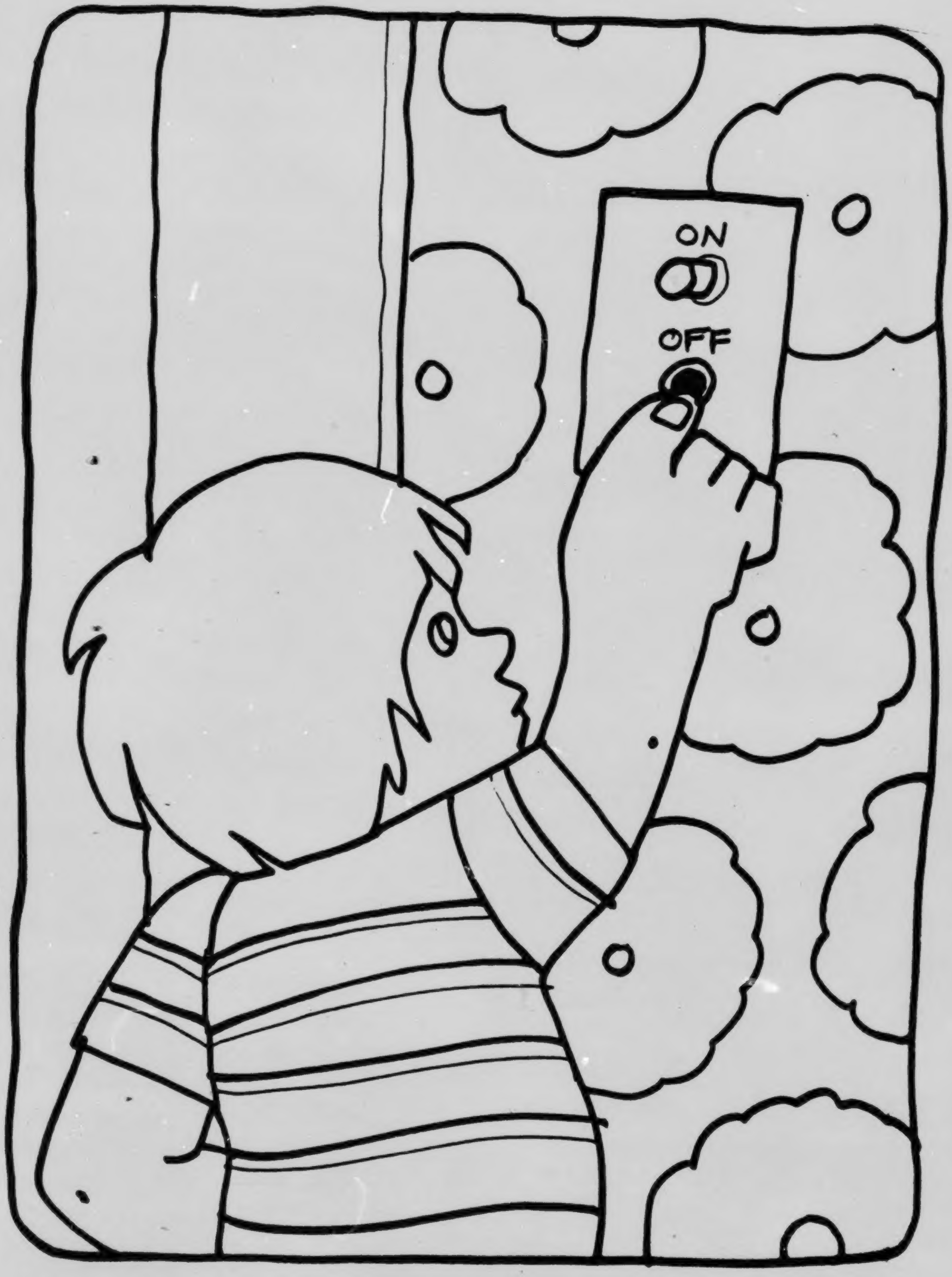
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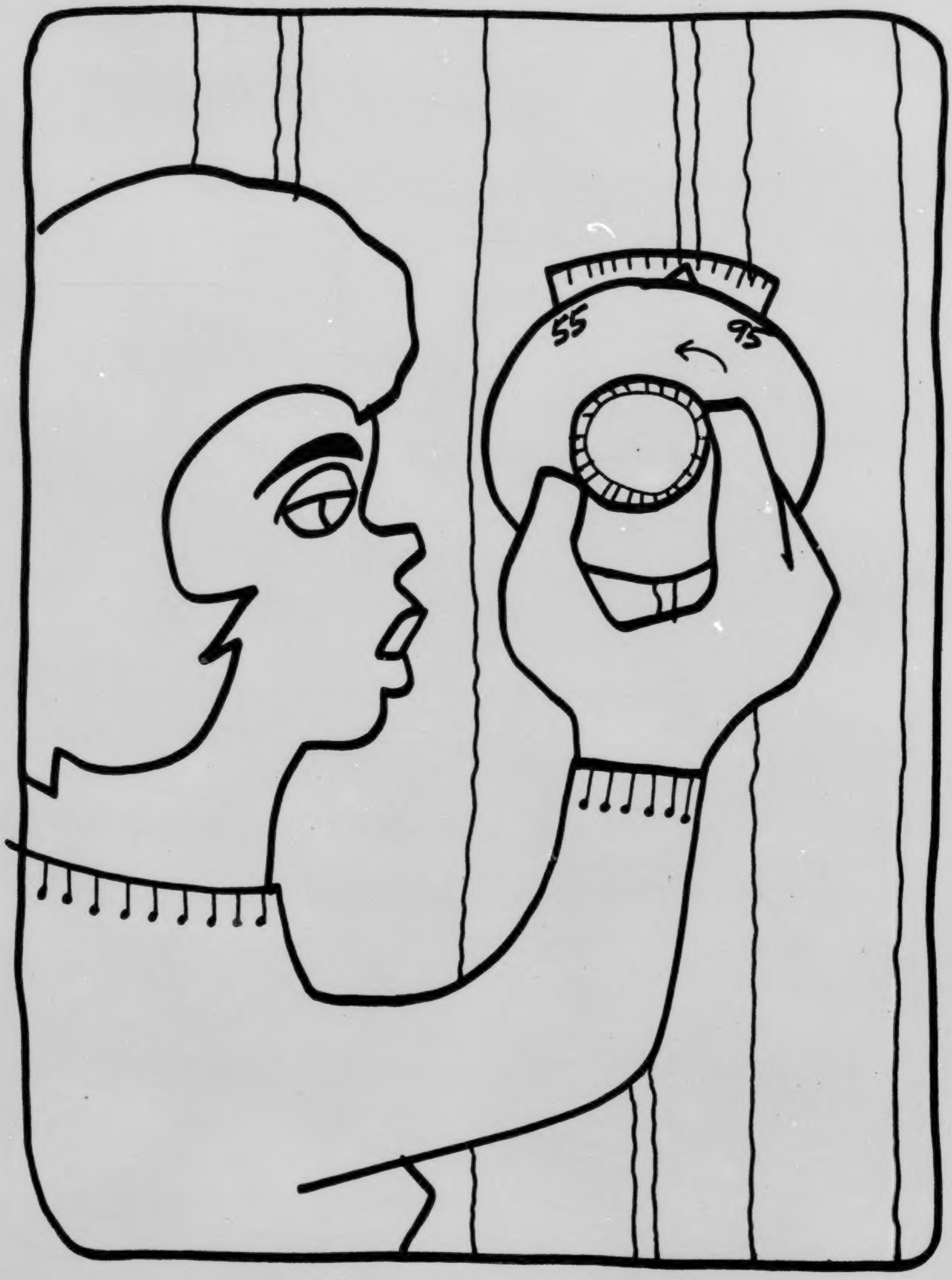
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Watts-Watching

(Slide Presentation: Activity VI-12)

Slide	Narration
1. ENCORE	
2. Title Slide	
3. U.S. energy consumption	Energy demands in the United States are soaring. Consumption is doubling every 13 to 15 years. Electric utilities, represented by the pink areas, use more energy than transportation, industry, residential and commercial sources.
4. Energy monster	Americans comprise a small 6% of the earth's population, yet we are literally "gobbling" up 1/3 of the energy used by the entire world.
5. Graph	Why are there increasing demands for energy? Because our present style of living requires more and more energy. Consumption: automobiles, heaters, air conditioners, stoves, color televisions, dishwashers, hair dryers, black and white televisions and electric mixers.
6. Coffee maker, toaster	Electrical appliances are using up a big portion of this energy.
7. Refrigerator	(Pause)
8. Chandelier	It takes as much electricity to burn a 100 watt light bulb for 10 hours as it would to lift a 150 pound person 17,700 feet in the air. That's over three miles high!
9. Kilo with stop sign	We are running out of the fossil fuel supplies that produce electricity so we must conserve our resources and stop wasting it today. It took hundreds of millions of years to create our vast natural resource reserves . . .
10. Coal pit	Yet, we are stripping and draining these reserves at an alarmingly fast rate. We waste almost half of the energy we use.

11. Secondary electrical lines	With the increased emphasis on energy and its conservation, we should become aware of our own electrical energy consumption.
12. Digital watt meter	A good way to start is to become a "watts-watcher". Knowing how to read a watt-hour meter can make us aware of home electrical energy consumption. There are two kinds of watt-hour meters: one has digital numbers that read from left to right . . .
13. Dial meter	The other has dials. Note, two dials read clockwise, and two read counter clockwise. Always read the lowest or smallest number that the arm is pointing toward. If it is between the two numbers, read the lowest, not the nearest. This meter reads: 8162.
14. Dial meter	Now it reads 9260. To find the amount of kilowatt hours used, subtract the first reading from the second: 9260 - 8162 = 1098 kilowatt hours.
15. Gas meter	Learning to read a watt meter can help you learn to read a gas or water meter, too.
16. Meter	The dials of this gas meter read in the same manner as the dials on a watt meter.
17. Power plant	Electrical power is being produced at many plants throughout the country. Plants similar to this one generate power to your home.
18. Watt meter	The watt meter is the power company's way of measuring how much electricity you consume. Help Kilo conserve energy by watching your watts.
19. The End	

RESOURCE LIST

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ENCORE

Chapter 7

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. write out the results of an experiment concerning the effects of the insulation and building materials of a house, after having observed the experiment.

2. describe orally what construction techniques are advantageous to conserving energy.

3. define a list of vocabulary words related to energy conservation and home construction.

ENERGY CONSERVATION AND HOME CONSTRUCTION

As a first step toward conserving energy, you might consider the insulation and weatherstripping of your own home. It has been estimated that 15 - 30% of most home heat is lost due to inadequate insulation and poor weatherstripping practices. The following chart may be helpful in determining insulation requirements.

Insulation Requirements

Heating System	Ceiling Inches of Thickness	Walls Inches of Thickness
Electrical	9	3 1/2
Gas or oil	6	3 1/2

If the insulation in your home does not meet these standards, you probably are wasting the energy that is used to provide the heat. Walls and ceilings should be well insulated and in some areas, floors should be insulated, also. Since heat rises, the insulation in the ceiling must be thicker than the insulation that is placed in walls and under floors. Some insulation types are rock wool, spun glass and asbestos. Insulation may be purchased in a "bound" form that comes in bats or rolls or it may be purchased in "poured" form that is installed by pouring from a container. The cost for insulation will vary form area to area. However, once your family installs the proper insulation, you will start to save money on your heating or electricity bill because you will be using less heat.

21C

In addition to insulation, storm doors and storm windows can help hold heat in a home. Weatherstripping and caulking around doors and windows will further reduce heat loss.

Although trying to keep heat from escaping from a home is an important energy conservation goal, homeowners must take some precautions to make sure the home is adequately ventilated. Homes that use space heaters with no outside vents can be hazardous if the insulation seals off all outside air. The lack of ventilation has resulted in several deaths over the past few years. Damage may occur to the interior wall structure (especially sheetrock) if the ventilation is bad. Floor ventilation is preferable because the air under the home has stabilized.

The humidity in a home is another important factor in heating a home. In order to keep comfortable, a home that is too dry during the winter must be kept warmer than one with a proper humidity level. Although a humidifying device may consume energy, using a humidifier will increase comfort and could result in an overall saving in energy.

The house structure has a bearing on heat loss. Brick or stone structures, properly built, are considered to be superior for retaining heat. The wood frame or box house is next in efficiency, with the steel structure the least efficient.

The fireplace has become a popular component, and is being used in more and more homes. In the early days the fireplace was an essential part of every home and in some instances, provided the only source of heat. Most homes today that have a fireplace also have a modern space heating system--usually central control heating. Several kinds of wood may be used in the fireplace. The most desirable wood is one that delivers the greatest amount of heat with the least amount of smoke and/or flame.

Oak wood is considered to be an excellent fuel for the fireplace.

Although the fireplace is a source of heat, it also can contribute to heat loss. The heat provided by the central heating system can escape through the open fireplace and chimney. For this reason, the fireplace damper should always remain closed when the fireplace is not being used. When a fire is burning in a fireplace at bedtime, block the entrance of the fireplace with a shield so that the fire can burn out without pulling warm air from the house.

The temperature that is maintained in one's home is an important factor in conserving energy. Heating cost and the use of energy increases significantly for each degree above 70°. An experiment revealed the fact that heating costs rise about three percent for each degree on the thermostat. If rooms have individual thermostats, avoid thermostat adjustments that vary more than three to five degrees from room to room, unless connecting doors are closed. Contrary to popular belief, turning the thermostat up or down does not save energy. It operates the heating unit erratically, thereby using more power. Experiments have revealed that the current surge of a one horsepower, 110 volt motor will be as high as forty amperes. This current surge occurs each time the motor is turned on and is much larger than the normal operating current for the motor.

The position of one's home to the sun is important. Windows should be on the side of the structure that will best capture the sun's rays. Let the sun furnish free heat. Keep shades and draperies open on the sunny side of the house during the daylight hours, but close them at night for added insulation. The only other factor that would alter the use of the sun through the windows is if the chill factor caused by high winter winds on the same side would offset the energy derived from the sun. One can readily see that if the sun's rays increase the heat by 20% and the chill factor caused by the wind on the glass diminished the temperature by 25%, the choice is evident. Closable storm shutters and heavy curtains should be used.

So you can see that there are many factors that can affect heat loss from a house. The color, position, geographic location are just some of the factors in determining heat loss and the amount of energy required to heat your home. The materials that your house is made of and your common sense also affect the heating of your home. In years to come, these materials and construction techniques will be even more important as heating and energy costs rise.

ACTIVITIES

1. Complete the "Conservation Checklist" for your own home. Discuss your findings with your classmates (Activity VII-1).

2. Invite a building contractor to visit and speak to your class about residential home construction and energy efficient construction methods (Activity VII-2).

3. Go on a field trip to a home construction site. Observe the insulation and notice how it is installed. Take notes on the design of the house, its orientation and construction methods in regard to energy conservation (Activity VII-3).

4. Define the vocabulary words (Activity VII-4).

5. The following activity is optional. Construct the ENCORE house and conduct the following experiments concerning heat loss (Activity VII-5).

   A. effects of different types of building materials

   B. effect of insulation

   C. effect of single versus double pane windows

   D. effect of color

   E. effect of opening and closing doors often and leaving doors open

   For electronically-minded students, plans are attached for constructing an electronic door opener for the ENCORE house. It simulates the effect of your own door being opened and closed.

Conservation Checklist for your Home

(Activity VII-1)

This checklist is provided so you might inspect your home and complete the checklist. The information will allow you to determine how well your home is conserving heat and coolant energy. The teacher may decide to have a class discussion after completion of the checklist to compare the results.

	Check with X	
I. Exterior		
Do you	Yes	No
A. Have brick and/or wood siding		
B. Have only brick siding		
C. Have storm windows		
D. Have tight fitting doors and windows		
E. Have brick or wood with cracks not caulked		
F. Have trees for wind screens and sun protection		
G. Have any doors that open toward the North		
H. Have storm doors		
I. Insulated glass		
J. 3 pane window glass tinted with dead air space between		
K. Awnings over windows		
L. Patio cover		

II. Attic or Loft

	Check with X	
	Yes	No
Do you		
A. Have adequate insulation--in attic floor		
B. Have ventilators installed in the attic or loft		
C. Have vents		
D. Have circulation fans		
E. Have insulation between rafters		
F. Have storage in the loft or attic		

III. Bathrooms

	Check with X	
	Yes	No
Do you		
A. Have a ventilator power or plain open type		
B. Laundry in the bathroom		
C. Do maximum size loads		
D. Use correct temperature settings for washer loads		
1. appropriate fabrics for wash cycle		
2. use cold water where possible (example: rinse with cold water)		
3. use proper cycles		
4. clean lint traps regularly		
5. dry fabrics outside when practical		
6. dry with fully loaded dryer only		
7. have dryer vented properly		

IV. Water Heaters

	Check with X	
	Yes	No
Do you		
A. Drain yearly and remove sediment		
B. Have the correct capacity water heater for your home		
C. Have controlled temperature settings (140° to 150° best settings for most kitchens and laundry needs)		
D. Fix any and all leaky faucets		
E. Insulate pipes		
F. Watch your use of hot water		
1. Take showers (showers use about half as much hot water as an average tub bath)		
2. Use a dishpan for washing and rinsing when done by hand		
3. Use your dishwater for storage until you have a full load		
4. Wash your cars or trucks using hot water		

V. Central Heating Systems

	Check with X	
	Yes	NO
Do you		
A. Have a yearly maintenance service performed on your furnace by professionals		
B. Forced air heat		
1. oil the blower (or grease)		
2. oil the motor (or grease)		
3. change or clean the filters frequently (2 times a season is recommended by most furnace manufacturers)		
4. clean the humidifier		

Check with X

Yes No

C. Check ducts

1. for leaks or separations

2. have the correct amount of insulation around the pipes or airways

VI. Air Conditioning

Check with X

Yes No

Do you

A. Interior

1. Overcool (The temperature difference between indoors and out should not exceed 15°)

2. Keep air filters clean

3. Have drapes or furniture obstructing the air flow

4. Shade windows from direct sun in summer with awnings or trees

5. Close or seal all passages or openings between air-conditioned space and the attic or loft including cracks around doors, windows, and stairways

6. Keep up maintenance of forced air system

a. change filters

b. air blower

c. keep condensation drain open

d. block chimneys with draft block or close draft on chimney with any means available

B. Exterior

1. Maintain outdoor unit for most efficient operation

2. Cover unit outdoors when not in use

3. Paint unit

a. grease as required by manufacturer

b. lubricate when required

VII. Kitchen

Check with X

Yes No

Do you

A. Oven

a. Preheat too long? (Don't preheat longer than 10 minutes and then only leavened foods and pastry require a preheated oven.)

b. Try to cook as many things as possible in the oven at the same time?

c. Avoid opening the oven door? Opening the oven door can cause as much as 20% heat loss.

d. Avoid using the oven to warm up the room?

e. Have an electric oven?

f. Have a gas oven?

g. Have an oven other than gas or electric?

B. Range

a. Cover pans whenever possible?

b. Avoid violent boiling?

c. Tailor flame or heat settings to size of pan?

d. Use controlled burner whenever possible?

e. Make use of kitchen exhaust fan?

VIII. Garage

	Check with X	
	Yes	No
Do you		
A. Have a garage that is part of the house? (If so, answer the following.)		
a. Leave the garage doors open?		
b. Have a laundry in the garage?		
c. Have the dryer vented properly (if in the garage)		
d. Leave the entrance to the garage from the house open always? sometimes? never? seldom?		
e. Leave garage windows open sometimes? always? never? seldom?		
f. Heat your garage?		
g. Air condition your garage?		
B. Have a separate garage?		
a. Have a way to heat it?		
b. Have a means to cool it?		

Vocabulary

(Activity VII-4)

1. absorb -

2. caulk -

3. dead-air space -

4. foundation -

5. insulation -

6. reflect -

7. storm door -

8. storm windows -

9. thermostat -

10. ventilation -

11. weatherstripping -

ENCORE House Experiments

(Activity VII-5)

The purpose of these experiments is to determine the heat loss from an enclosure (ENCORE house) under varying conditions. The ENCORE house was designed with removable walls and a removable roof to facilitate the experiments. The heat source will be an electric lamp. Since the procedures for all the experiments are similar, they will be described only once.

Procedures (Use data sheet to record information.)

1. Construct the ENCORE house for the experimental condition.
2. Place a centigrade thermometer into the house through a small hole in the roof.
3. Turn on the electric lamp and heat the house for five to ten minutes.
4. Turn the lamp off. Record the time and the house temperature in the data sheet as start time and initial temperature.
5. At intervals of two minutes, record the house temperature.
6. After ten minutes, record the temperature and time. Record the time and temperature in the data sheet as finish time and final temperature.
7. The difference between initial temperature and final temperature will be the temperature differential (ΔT).

A. Effect of Different Types of Building Material and Dead Air Space

1. Single thickness cardboard
    - a. Assemble the ENCORE house with a single wall made of cardboard
    - b. Conduct the experiments as described.
2. Double thickness cardboard
    - a. Assemble the ENCORE house with double walls made of cardboard.
    - b. Conduct the experiments as described.

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3. Single thickness masonite

    a. Assemble the ENCORE house with a single wall made of masonite.

    b. Conduct the experiment as described.

4. Double thickness masonite

    a. Assemble the ENCORE house with double walls made of masonite.

    b. Conduct the experiments as described.

B. Effect of Insulation

1. Insulation and double walls

    a. Assemble the ENCORE house with double walls made of masonite. Place an insulating material between the walls.

    b. Conduct the experiment as described.

C. Effect of Single versus Double Pane Windows

1. Single pane window

    a. Assemble the ENCORE house with any wall structure desired. Make a window of single pane glass.

    b. Conduct the experiment as described.

2. Double pane window

    a. Assemble the ENCORE house with the same wall structure as before. Use a double thickness window pane.

    b. Conduct the experiment as described.

D. Effect of Opening and Closing Doors

1. Open the door every two minutes and keep the door open for five seconds.

    a. Construct the ENCORE house with any of the previous methods.

    b. Conduct the experiments as described.

    c. Compare this experiment with the experiment that was done with the ENCORE house using the same construction methods.

Conclusions

Use the data sheets to compare the heat loss from the ENCORE house with varying conditions.

1. Was there a difference between types of building materials?

2. Was there a difference between single wall and double wall construction?

3. Was there a difference between double wall construction and double wall construction with insulation?

4. Was there a difference between single glass and double glass windows?

5. Was there a difference between an experiment that did not open doors and the experiment that opened doors?

EXAMPLE OF DATA SHEET

Experiment Number ____________ T/min. __________________

Date: _______________________

Materials: _________________________

____

____

____

____

Data:

Start Time ____________________ Finish Time ____________________

Initial Temperature ____________ Final Temperature ______________

2 minutes _____________________

4 minutes _____________________

6 minutes _____________________

8 minutes _____________________

10 minutes _____________________ (Final)

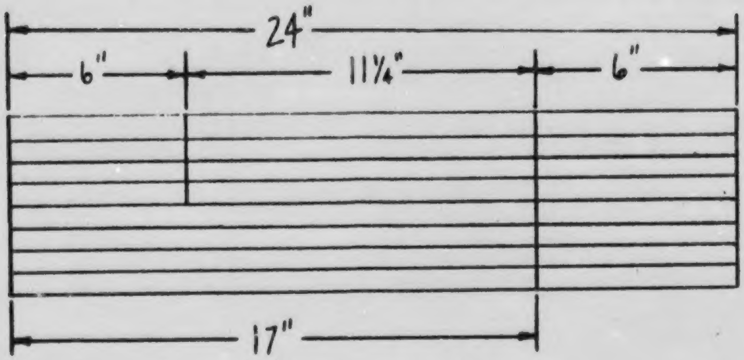
$(T_{Final} - T_{Initial}) = \Delta T$ _____________

$\frac{(T_{Final} - T_{Initial})}{\# \text{ of minutes}} = \Delta T/\text{min.}$ __________

ENCORE House Construction Procedure

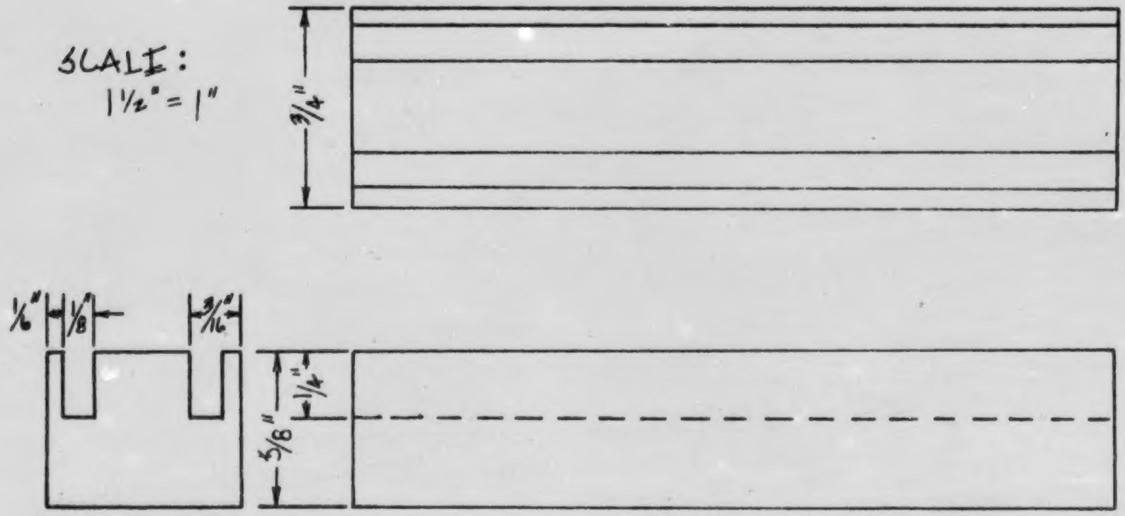
(Activity VII-5)

1. Rip the 1" X 6" pine into eight pieces that are 5/8" wide.
2. Cut: 4 pieces 17" long
   10 pieces 6" long
   4 pieces 11 1/4" long
   1 piece 6 1/2 " long



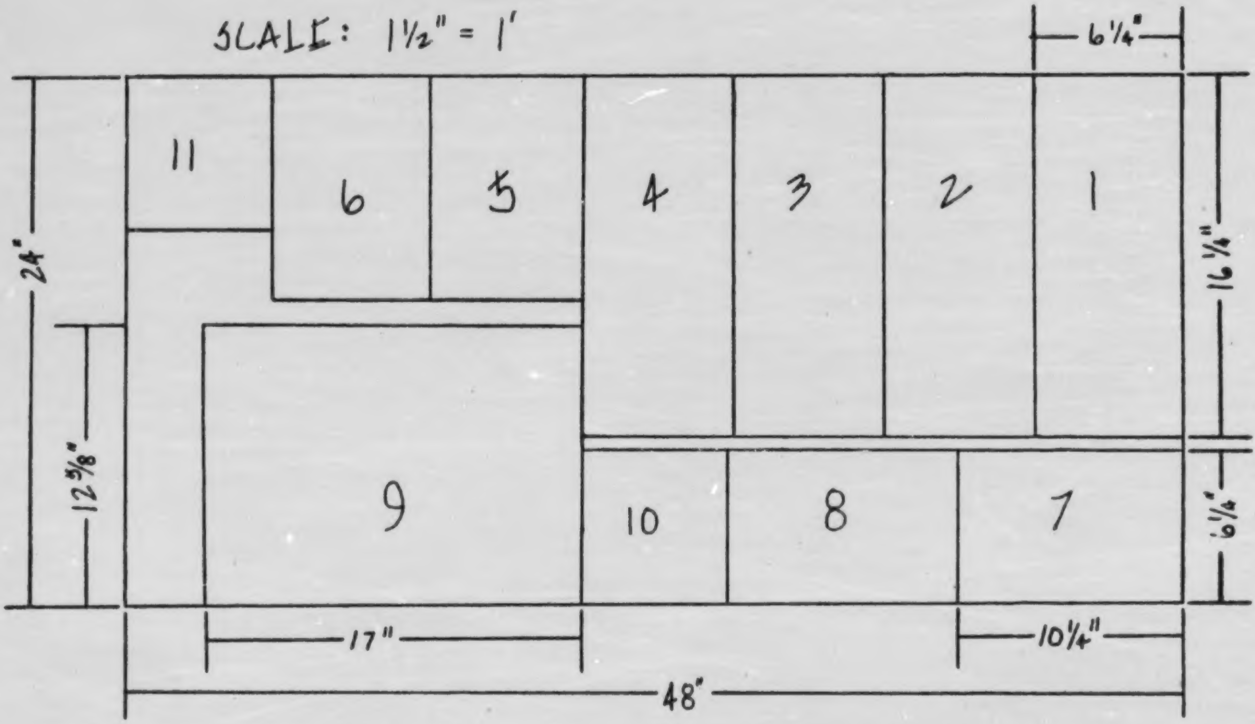
3. Dado: 2 17" pieces
   10 6" pieces
   2 11 1/4" pieces

(2 dados per piece, 1/8" wide, 1/4" deep, and 1/16" from edges)

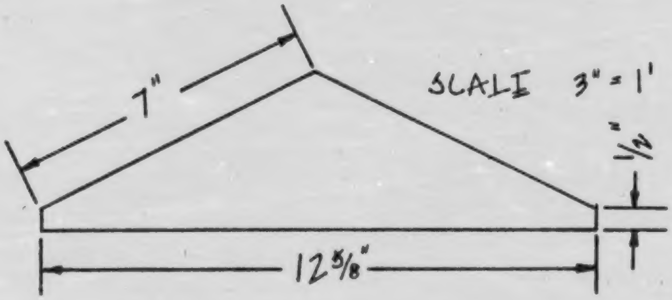

SCALE:
1½" = 1"
3/4"
1/16"
1/8"
3/16"
1/4"
5/8"

4. Cut masonite board into:

4 pieces 6 1/4" X 16 1/4"	(numbers 1, 2, 3, 4)
4 pieces 6 1/4" X 10 1/4"	(numbers 5, 6, 7, 8)
2 pieces 5 1/2" X 6 1/2"	(numbers 10, 11)
1 piece 12 5/8" X 17"	(number 9)

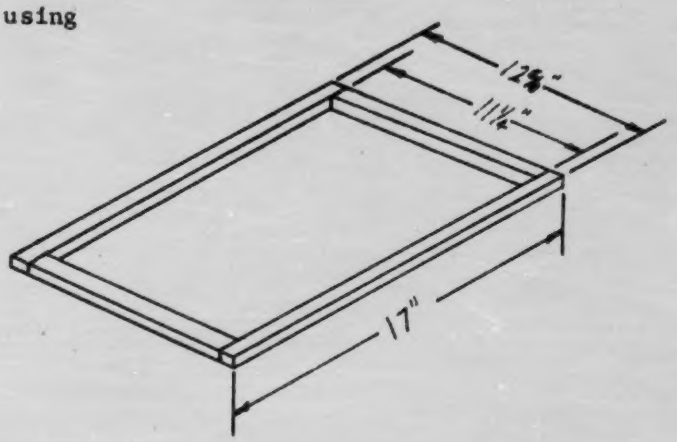

SCALE: 1½" = 1'
6¼"
11
6
5
4
3
2
1
24"
16¼"
12⅝"
9
10
8
7
6¼"
17"
10¼"
48"

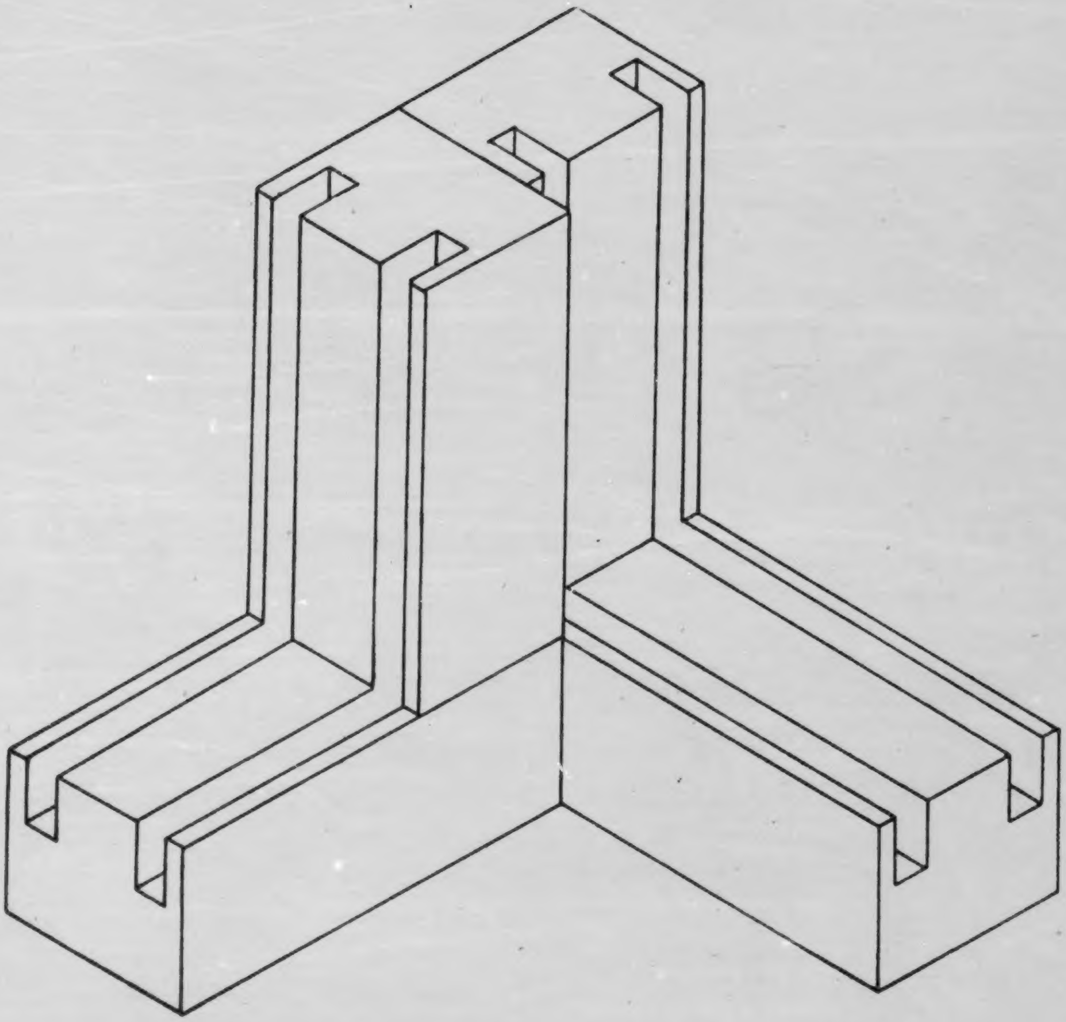
5. Cut cardboard same as masonite, excluding #10 and #11, but adding
2 pieces 7" X 7" X 1/2" X 1/2" X 12 3/4" (gables)
1 piece 15 1/2" X 25" (roof)


7"
SCALE 3" = 1'
½"
12⅝"

6. Cut glass same as masonite, excluding #9, #10, & #11

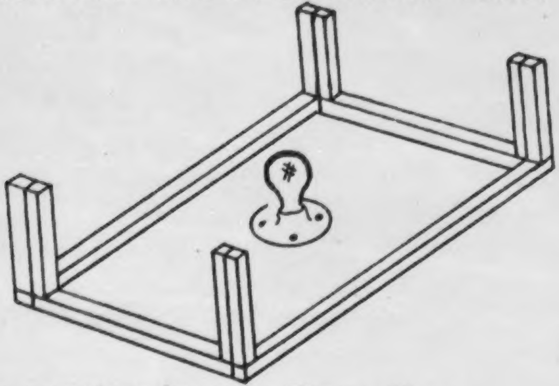
7. Glue house frame together using
8 pieces 6" long
2 pieces 11 1/4" long
2 pieces 17" long





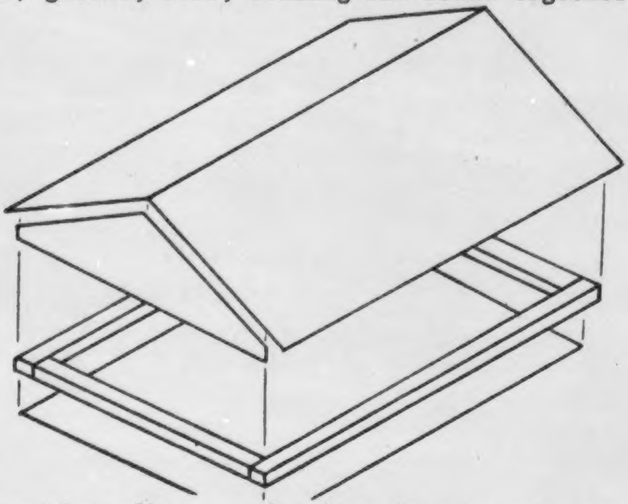
8. Nail and glue pine frame to 12 3/4" X 17" masonite floor.

9. Cut a 1/2" diameter hole in the middle of the floor.

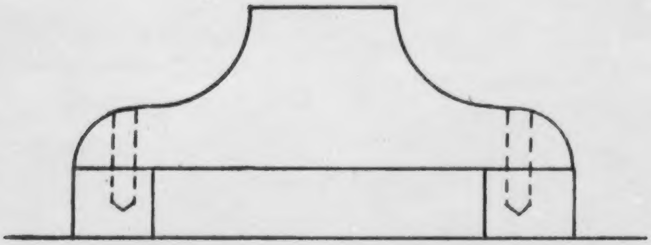


10. Glue roof frame together (same as Figure 5).

11. Glue (or staple) gables, roof, ceiling and frame together.



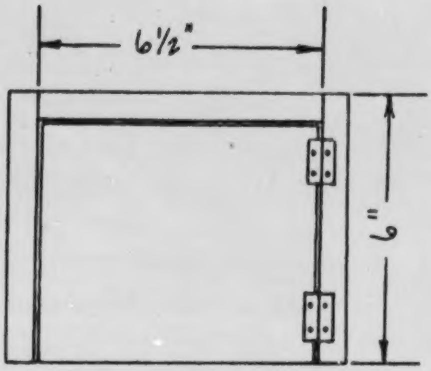
12. Glue blocks of wood to floor, under lamp fixture, so screws will not go through floor.



13. Attach electrical cord to lamp fixture.

14. Glue door frame together using

Two 6" pine pieces
One 6 1/2" pine piece



15. Attach door to frame with two hinges using #10 and #11 masonite boards glued together for door.

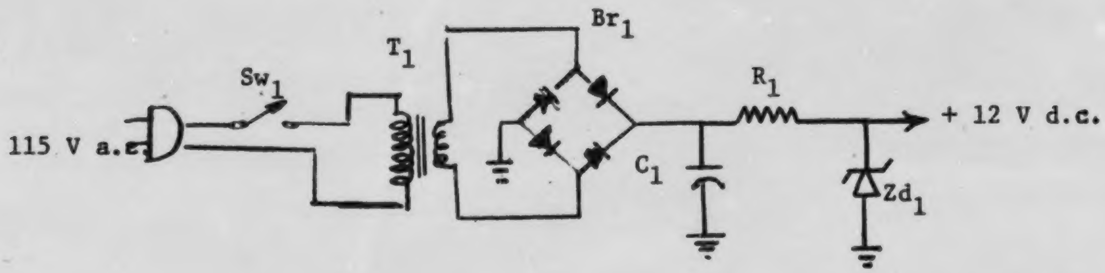
NOTE: If door is used, a numbered 1, 2, 3, or 4 piece will have to have a 7 1/2" piece cut from the middle of the wall where the door is inserted.

Optional Activity VII-5

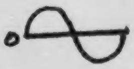
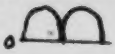
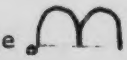
Circuit Description

The circuit is basically a time dependent control circuit. For the application at hand, we wish to open a door at variable intervals of time and to keep the door open for variable intervals of time. The circuit may be broken into three major components: the power supply, turn on circuit and turn off circuit.

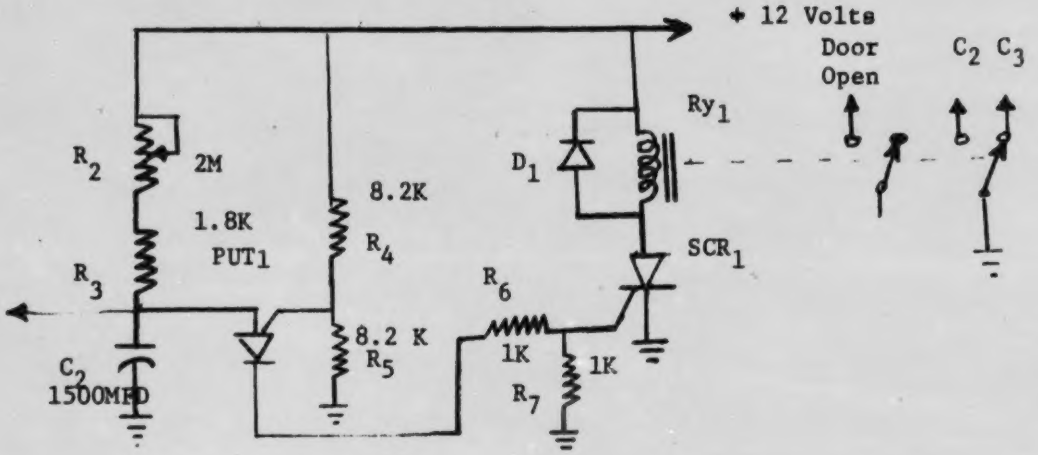
The Power Supply Circuit



The purpose of the power supply is to convert the 115 volt a.c. line voltage to a regulated 12 volts d.c. in the following manner.

1. Sw_1 applies 115 volts a.c. to transformer T_1.
2. Transformer T_1 steps the 115 volts a.c. down to 12.6 volts a.c. (rms values).
3. Bridge rectifier Br_1 changes the 12.6 volts a.c.  into a pulsating d.c. voltage 
4. Capacitor C_1 changes the pulsating d.c. voltage  into an even level d.c. voltage of 17.6 volts (rms X 1.4; 12.6 X 1.4 = 17.6)
5. Resistor R_1 and Zener diode Zd_1 form a regulator circuit that maintains a constant 12 volts d.c.

The Turn On Circuit



The timing portion of the turn on circuit consists of capacitor C_2, potentiometer R_2 and resistor R_3. Resistor R_3 has minimal effect on the circuit; its purpose being to protect the power supply. The timing circuit operates on the principle of the time constant. A time constant is the length of time required for a capacitor to charge to 63% of the applied voltage (12 volts) and is determined mathematically by the multiple of the resistance and capacitance in the circuit. In this circuit the resistance is variable from 1.8 K ohms to 2 M ohms. Therefore, the time constant in this circuit will vary from 2.7 seconds - 3000 seconds:

Time Constant = Resistance X Capacitance = $(1.8 \times 10^3)\ (1500 \times 10^6) =$

2700×10^{-3} sec.

Time Constant = Resistance X Capacitance = $(2 \times 10^6)\ (1500 \times 10^{-6}) =$

3000 seconds

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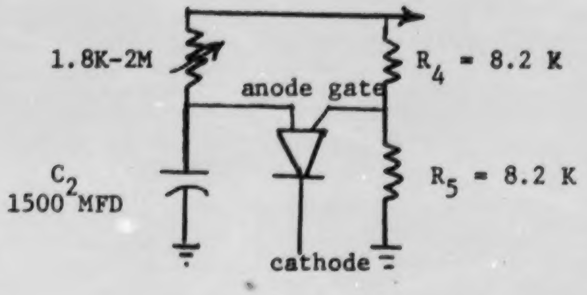
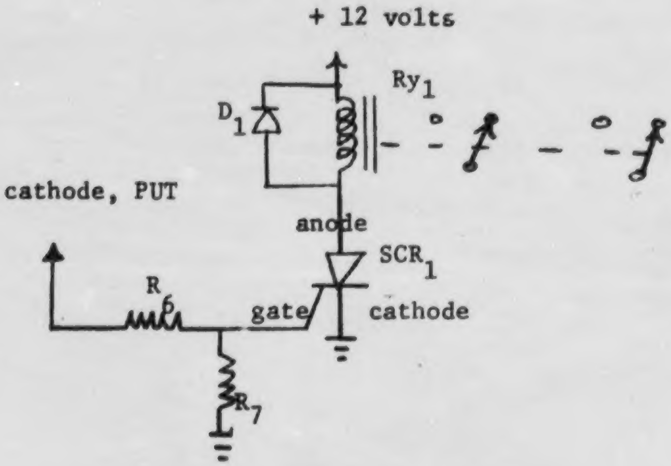
The next portion of the circuit consists of a programmable unijunction transistor. The PUT (programmable unijunction transistor) operates as follows:


1.8K-2M
R_4 = 8.2 K
anode gate
C_2
1500 MFD
R_5 = 8.2 K
cathode

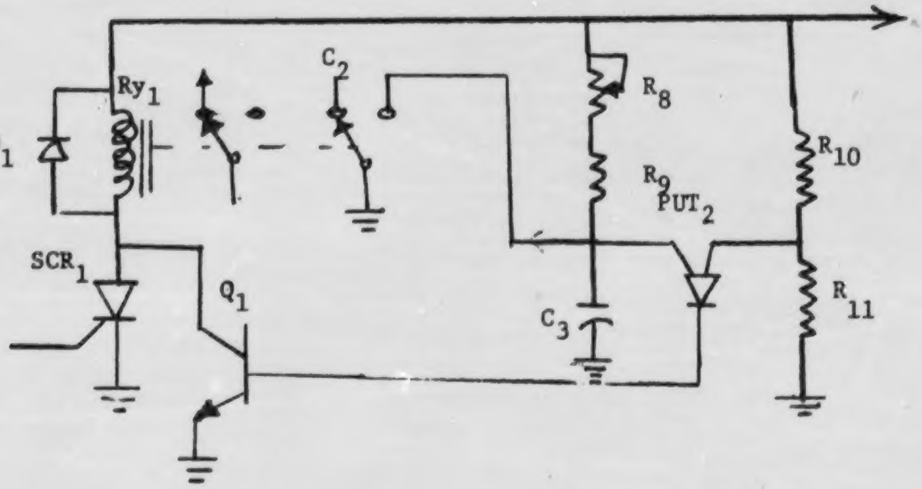
The term programmable relates to the establishment of a voltage on the gate lead. In this circuit, R_4 and R_5 have equal values; therefore, the voltage on the gate lead will equal 6 volts. The voltage on the anode lead is the time dependent, and will vary as capacitor C_2 charges. As soon as the voltage on the anode lead exceeds the voltage on the gate lead, the PUT behaves as a switch, and conduction takes place between the cathod lead and the anode lead. The PUT is used as a switch to turn the Silicon Controlled Rectifier (SCR) on.

The SCR portion of the circuit operates as follows:


+ 12 volts
Ry_1
D_1
cathode, PUT
anode
SCR_1
R_6
gate
cathode
R_7

The SCR is basically a switch. With a positive voltage applied to the anode, the SCR will turn on (switching action) when the voltage applied to the gate lead exceeds the cathode voltage. When the SCR is turned on by the voltage on the gate lead, the SCR will remain turned on until (1) the voltage on the anode goes negative, or (2) the circuit is broken, or (3) the current flowing from the cathode to anode drops below a holding level. When the PUT turns on, a voltage is applied to the gate lead of the SCR, turning it on. The SCR acts as a switch that energizes Relay_1 causing the door to open. The door will remain open until we cause the SCR to stop conducting and de-energize Relay_1. We will use a turn off circuit to cause the SCR to stop conducting by method (3).

The turn-off circuit operates as follows:



The turn off circuit uses a PUT circuit similar to the turn on circuit. The timing circuit consists of capacitor C_2, potentiometer R_8, and resistor R_9. The resistance is variable from 100 K ohms to 1.1 M ohms; therefore the time constant in the circuit will vary from 2.5 sec. - 28 sec.

Time Constant = Resistance X Capacitance = $(100 \times 10^{3})\ (25 \times 10^{-6}) =$

$2500 \times 10^{-3} = 2.5$ seconds

Time Constant = Resistance X Capacitance = $(1.1 \times 10^{6})\ (25 \times 10^{-6}) =$

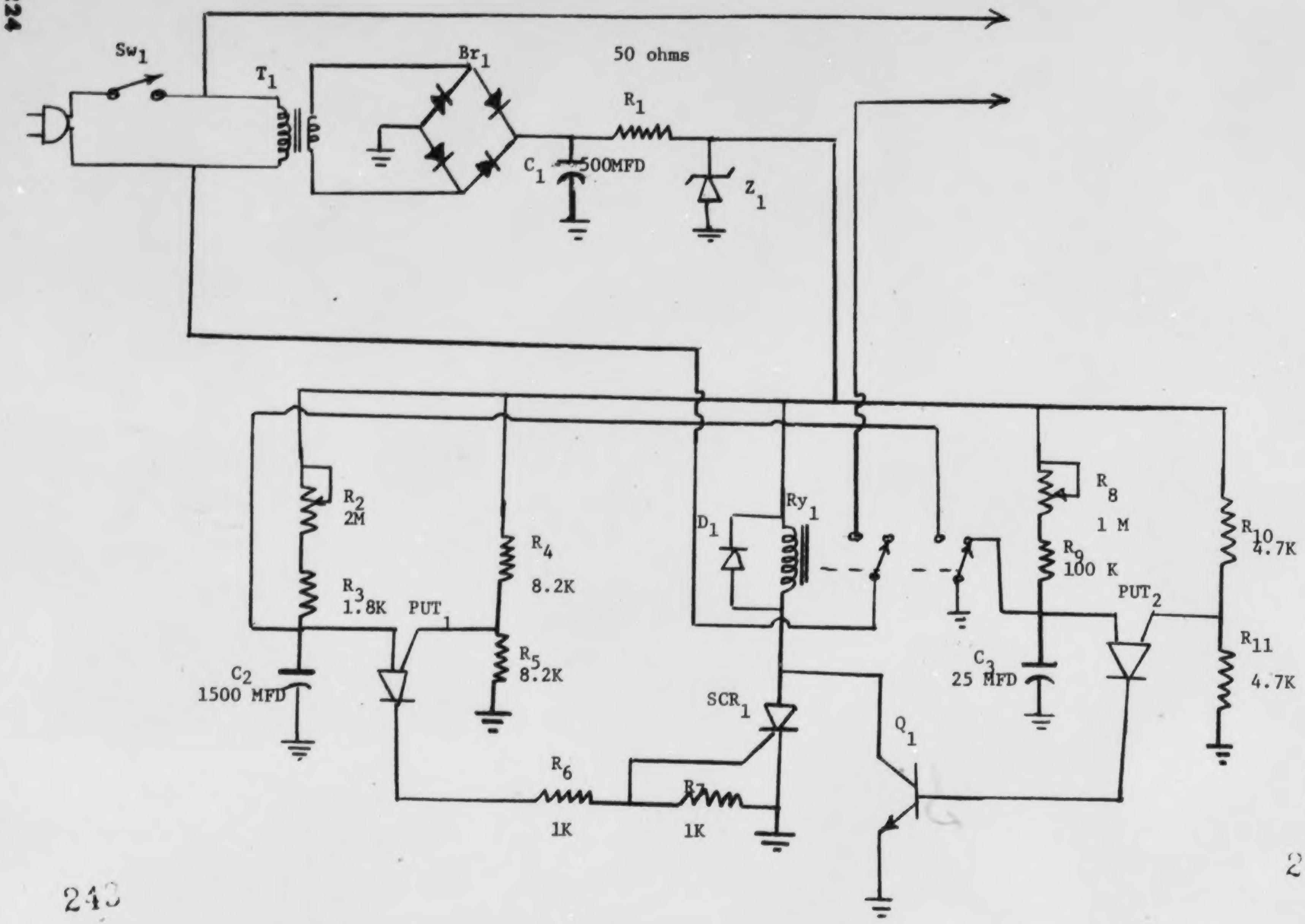
27.5 seconds

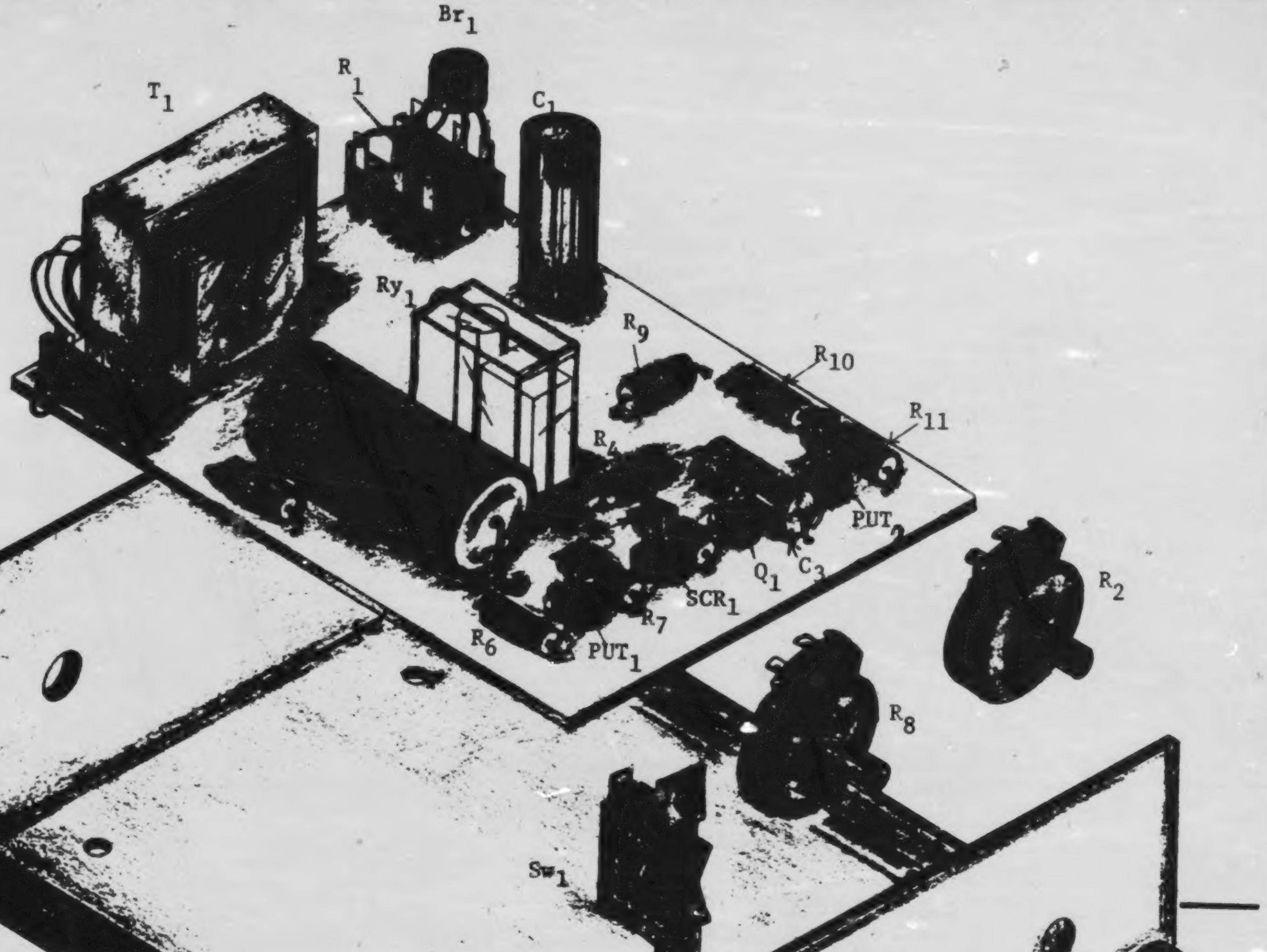
The circuit operates in this manner. When the SCR is turned on, relay Ry_1 is energized. Two things happen (1) the door is opened by one set of contacts on the relay and (2) the other set of contacts on the relay remove the ground connection from capacitor C_3, allowing it to start charging. In some length of time, depending on the value of the resistance in the circuit, capacitor C_3 will charge to a voltage whereby the anode voltage of PUT_2 exceeds the voltage on the gate lead causing the PUT to turn on. Conduction will take place between the anode and cathode leads of the PUT_2 and this will apply a forward bias voltage on the base lead of transistor Q_1 causing it to conduct heavily. The heavy conduction by transistor Q_1 will cause the current flowing through the SCR to drop below a holding level; therefore, it will turn off and the relay will deenergize. The relay contacts remove the voltage from the door circuit, allowing the door to close, and the ground is removed from capacitor C_2 and applied to capacitor C_3. The door opens (turn on circuit now begins a repeat operation).

Parts List

Number required	Description	Radio Shack #
1	Transformer 12V CT, 1.5A	273-1505
1	Switch, SPST	275-611
1	* Line Cord	61-2750
1	Bridge Rectifier, 2A, 100PIV	276-1152
1	500 MFD, 50V Capacitor	272-1030
1	Zener diode, 12 V, 1 Watt	276-563
2	*100 ohm, 1/2 watt resistors	271-012
1	2 M ohm Potentiometer	271-093
1	1 M ohm Potentiometer	271-211
1	1.8 K ohm resistor, 1/2 watt	271-026
2	8.2 K ohm resistors, 1/2 watt	271-033
2	4.7 K ohm resistors, 1/2 watt	271-030
2	1 K ohm resistors, 1/2 watt	271-023
1	100 K ohm resistor, 1/2 watt	271-045
2	Programmable Unijunction Transistor	276-119
1	NPN transistor	276-2009
1	Silicon Controlled Rectifier, 1A, 100PIV	276-1059
1	Relay, DPDT, 12V	275-206
1	Rectifier, 1A, 600PIV	276-1104
1	1500 MFD, 35V Capacitor	
1	25 MFD, 35 V Capacitor	272-1014
1	Cabinet Enclosure	270-253
2	Terminal Strips	274-686
4	Transistor sockets	276-548
2	Rubber grommets	
1	Perfboard	276-1394
	Hook-up wire	278-1305
2	Knobs	

The total cost for this activity was $31.69 based on 1976 prices.


Sw$_1$
T$_1$
Br$_1$
50 ohms
R$_1$
C$_1$
500MFD
Z$_1$
R$_2$
2M
R$_3$
1.8K
PUT$_1$
R$_4$
8.2K
R$_5$
8.2K
C$_2$
1500 MFD
R$_6$
1K
R$_7$
1K
SCR$_1$
D$_1$
Ry$_1$
Q$_1$
R$_8$
1 M
R$_9$
100 K
C$_3$
25 MFD
PUT$_2$
R$_{10}$
4.7K
R$_{11}$
4.7K


T1
R1
Br1
C1
Ry1
R9
R10
R11
R4
PUT2
Q1
C3
R2
SCR1
R7
R6
PUT1
R8
Sw1

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide information on energy conservation and home construction. This chapter contains basic information on building materials and insulation requirements that every future homeowner should know. Students should read and discuss the information section before beginning activities.

Only a few activities are included, but they have been carefully selected to insure complete coverage of the basic concepts. For Activity VII-1 provide checklists for each student. Tell the students that if they are not sure about a particular item on the checklist to just skip it. Do not answer "yes" or "no" unless they are certain. Activity VII-2 and 3 are a field trip and guest speaker. Prime the students beforehand in order to make the experiences more beneficial.

The last activity will require the help of the wood shop personnel. This is an excellent activity and should not be overlooked because of its relative complexity. Once an ENCORE house is built, it can be used year after year by science classes, architecture classes, wood shop classes, etc. The results of the activity will be surprisingly realistic and exemplify residential heating problems rather well. Discuss this experiment and run any additional tests on it. Reverse the experiments and test the house for loss of cool air as well. Be creative.

List of Materials

Activity VII-1

Conservation Checklist in hand-out form

pen or pencil

Activity VII-3

a home construction site

field trip accommodations

Activity VII-4

vocabulary words in hand-out form

pen or pencil

Activity VII-5

2 feet	1" X 6" pine
1 sheet	Masonie 48" X 24"
1	Cardboard box (34" X 34" X 34")
4	Glass (7" X 16 1/4" X 1/8")
4	Glass (7" X 10 1/4" X 1/8")
1	Household Extension Cord (minimum 3' long)
Opt.	Insulation of choice
1	Light fixture
1	#1 Superflood Lamp BBA
1	Centigrade thermometer (150°C)
1	Clock or watch with secondhand)
1 box	Wire brads (1/2" length)
1 bottle	Glue (wood) or Elmer's All Purpose

TEST

A. Underline the most energy efficient building materials or construction technique of each pair of words or phrases.

1. double pane or single pane windows?
2. open doors or closed doors?
3. two inches of insulation or 9 inches of insulation?
4. weatherstripping or no weatherstripping?
5. brick houses or metal houses?

B. Multiple Choice

6. Bad ventilation

   a. can damage the interior wall structure

   b. can kill the people in the house because of lack of air

   c. is sometimes caused by the insulation sealing off all outside air

   * d. all of the above

7. If you have a fireplace in your house, but the heater is turned on you should

   a. build a fire in the fireplace immediately

   * b. close the fireplace damper because the heat can escape through the chimney

   c. nothing

   d. stuff rags up the chimney

8. How much heat is lost from a house, due to poor insulation and weatherstripping?

   * a. 15 - 30%

   b. 1 - 15%

   c. 90 - 100%

   d. 5 - 10%

9. To help conserve energy, the windows on a home should

* a. face the sun as much as possible

b. be covered with wood in case of a tidal wave

c. be wide open when the air conditioner is on

d. always have closed curtains

10. The best kind of wood to use in your fireplace is

a. balsa wood

b. glen wood

* c. oak wood

d. wet wood

RESOURCE LIST

Articles

"All Year Energy Savings All Around the House," Potomac Power Company.

"Energy Conservation, Experiments You Can Do," Thomas Alva Edison Foundation, Cambridge Office Plaza, Suite 143, 18280 West Ten Mile Road, Southfield, Michigan 48075.

"Energy Conservation, Understandings and Activities for Young People," U.S. Government Printing Office, Washington, D.C. 20402.

"Energy: Plan to Use Peat as Fuel Stirs Concern in Minnesota," by Philip M. Boffey, American Association for the Advancement of Science, Vol. 190, Dec., 1975, p. 1066-1068.

"Handyman's Guide to Saving Heating Oil," Sun Oil Company.

"Heating Your House for Less," Energy Savings Begin at Home, Toledo, Ohio, Edison, pp. 10-11.

"Individual Action for Energy Conservation," Subcommittee on Energy, Committee on Science and Astronautics, U.S. House of Representatives, Ninety-Third Congress, U.S. Government Printing Office, Washington, D.C., 1973, p. 3.

"Solar Heating and Cooling," Science, by John Duffie and W. R. Beckman, January, 1976, Vol. 191, pp. 143-149.

"Solar Reports Evoke Cloudy Response," Science, November 1975, Vol. 190, No. 4214, p. 190.

"The Energy Saving Guide Book," Electrical Industries Association of Southern California.

"Tips for Energy Savers In and Around the Home," Federal Energy Administration, Washington, D.C. 12461.

"You May Be Wasting Comfort," Watts Going On Where You Live? General Electric Power Saving Guide to Major Appliance Energy Conservation, p. 2 and 3.

"Your Energy Conservation Check Out," Educational Services Program, Class Projects.

"Wave Power, The Problem is Taming It," by Michael Cusack, Science World, Vol. 32, No. 5, Englewood Cliffs, New Jersey, March 23, 1976, pp. 12-36.

"Wind Power, Can It Make a Difference?" by Bill Steele, Science World, Vol. 31, No. 7, Englewood Cliffs, New Jersey, December 2, 1975, pp. 14-17.

Pamphlets

"Dollar Wise Use of Electricity," from Houston Lighting and Power Company, Houston, Texas.

"Energy Saving Begins at Home," from Toledo Edison, Toledo, Ohio.

"All-Year Energy Savings All Around the Home," Potomac Electric Power Company, Washington, D.C.

"Insulation for Heating," University of Illinois, Champaign, Illinois, Small Homes Council.

Films

Energy Sources of the Future, available from McGraw Hill Films, 1221 Avenue of the Americas, New York, New York 10020. It's free. Excellent.

The Coal Connection, available from Utah Power and Light Company, 1407 West North Temple, P. O. Box 899, Salt Lake City, Utah 84110. Excellent. Free.

This World of Energy, available from National Geographic Society, Department 1037, Washington, D.C. 20036. Filmstrip. $67.50 to purchase. Excellent.

Here Comes the Sun, available from U.S. ERDA Film Library, Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee. Free. Excellent.

The Environment, available from Films Incorporated, 1144 Wilmette, Wilmette, Illinois 60091. $20 rental, very good.

Energy Choices, Options, and Decisions/with Study Guide, available from Houston Lighting and Power, 611 Walker, Houston, Texas Phone: (713) 228-9211 (Ext. 2032 Patti Amerman).

ENCORE

Chapter 8

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. devise a car pool system of transportation to and from school.
2. write down at least 10 "Energy Saving Tips" that he/she has actually been involved in at home, in the car, at school or out-of-doors.
3. complete an experiment on fuel consumption and:
    a) explain orally or in writing how a gasoline engine operates,
    b) adjust the ignition system,
    c) adjust the valves,
    d) adjust the carburetor,
    e) explain orally or in writing how gasoline consumption of a tuned engine differs from that of an untuned engine,
    f) explain orally or in writing how a gasoline engine operates on other fuels,
    g) adjust a gasoline engine so that it will operate on another fuel,
    h) conserve energy (gasoline and oil) and help the nation conserve its limited fossil fuels.

ENERGY SAVING TIPS

Automobile and Transportation Efficiency

The automobile uses large amounts of energy. Currently, we average 1.2 persons per automobile and travel at the maximum average of approximately 15 miles on each gallon of gasoline. Also, there are approximately 102 million passenger automobiles on the highways today. Automobiles may be shiny and luxurious, but they are necessary to the American economy and society. We are currently so dependent upon the automobile that to be without a car would cause most of us to withdraw from society.

The automobile is made up of hundreds of parts working together. Keeping those parts in top shape will increase efficiency. A well-maintained and properly driven automobile will provide as much as twice the number of miles per gallon of gasoline. It is unlikely that mileage increase will be realized, but a properly maintained automobile can help to conserve energy.

Maintenance Tips

1. Have your car tuned regularly. Untuned cars waste 5 billion gallons of gas annually.
2. Regular inspection might also reveal:
   a. a misfiring spark plug which can waste up to 1 mpg,
   b. a faulty carburetor choke which can waste up to 3 mpg, and
   c. a clogged air filter which can waste up to 1 mpg.
3. Keep your tires properly inflated. Under-inflated tires increase your vehicle's rolling resistance, making the engine work harder and use more gasoline, and tires also wear out faster. Check tire pressure when the tires are cold to get the most reliable reading.
4. Consider buying radial ply tires. Radial ply tires have lower rolling resistance than conventional tires. Most people realize a 1 mpg advantage. They last longer and are safer, too.

5. Check your vehicle's wheel alignment. Improper wheel alignment can result in fuel loss. Not only is your fuel being wasted but your tires are being worn excessively.

6. Maintain proper engine cooling temperature. The cooling system thermostat is an important factor in fuel economy. A faulty thermostat can waste gas by prolonging engine warmup in cold weather.

7. Ensure that your drive components are in good working order.

8. Keep the carburetor adjusted and the air cleaner free of dirt. The carburetor does not have to be "leaned-out" to extremes for good economy. Have it adjusted to factory specifications for the best economy. A dirty air cleaner restricts the flow of air to the carburetor, causing the engine to run on a richer mixture, thus using more gasoline than required.

9. Have your exhaust emissions checked. Efficiency of your automobile can be determined by the measurement of carbon monoxide (CO) and unburned hydrocarbons (HC). The necessary maintenance can be determined.

Driving Tips

1. Keep your speed down. High speeds increase the rate of gasoline your vehicle will use.

2. Do not ride your brakes or clutch. Ease off the accelerator pedal for slight slow-downs. Never use the brake or clutch as a foot rest.

3. Avoid unnecessary loads in the seat or cargo area. Fishing tackle and golf clubs should be stored at home instead of in the luggage compartment.

4. Do not pump the accelerator. Pumping the accelerator after starting the engine or at traffic lights puts wasted gasoline in your carburetor.

5. Pace your driving. Continuous stopping and starting of your vehicle reduces your vehicles miles-per-gallon performance considerably.

6. Avoid excessive idling. Do not let your engine idle for long periods during warm-up, or while waiting outside the school or supermarket. Letting the engine idle means you are getting zero miles per gallon. In the winter, drive slowly for the first 1/4 mile.

7. Avoid "Jackrabbit" starts. This type of driving uses about twice as much gasoline as "smoothed-out" starting.

8. Use your air conditioner sparingly. This comfort costs about 2 mpg, minimum.

9. Plan trips carefully. Combine short trips and avoid travelling at rush hours. Ask your neighbors to join you for grocery shopping. Buy groceries to last a week or more on each trip.

10. Do not "top off the tank." Fill your tank only partially full. Much is wasted in "sloshing" out, from expanding and running over during hot weather and from parking on an incline.

General Transportation Tips

1. Buy a car no larger or more powerful than you need, and no unnecessary features. Larger cars with more powerful engines consume more fuel than small ones.

2. Walk and ride bikes. Half of all automobile trips now cover less than 5 miles. Exercise is healthy, too.

3. Ride public transportation where available. Further, your use of these facilities will encourage the building of better public transportation systems in your community.

4. Organize car pools. Have three people join you in a car pool for a year. The gasoline that would be saved would equal your total annual needs for work and pleasure, plus 260 gallons extra for everyone.

Energy Tips For Building and Maintenance

Insist on good architectural design of your home and the buildings in your community. All buildings, whether for domestic, commercial or industrial use, should have windows that open to negate the need for heating, air conditioning and ventilation during moderate seasons. Also, encourage the design of all buildings with less glass.

All windows in every building should be shaded from direct sunlight. Good landscape design can allow windows to be shaded naturally, with trees, vines and shrubbery; however, shutters that close, roof overhangs and awnings provide adequate shading otherwise.

When building a new house, consider the heat gains when positioning it. There is more heat gained when facing the west and south than the the east and north. If the burden of your energy bill is on the air conditioner, you would do well to position your house favoring the north and east.

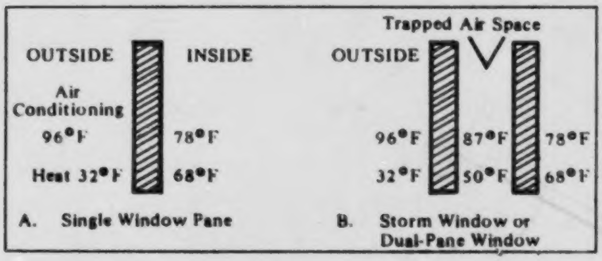
In selecting materials for your new house, "be natural" and save energy. Artificial materials generally take more nonrenewable energy resources to manufacture than do natural ones.

Also, demand that products be made to last. You may pay more initially, but in the long run you will be better off economically and less frustrated.

Windows and Doors

As much as 20 to 25 percent of heat and air conditioning is lost through and around windows and doors.

1. In the summer, use blinds, shades, or draperies to block direct sunlight and reduce the amount of heat entering the house.
2. In the winter, close the draperies to keep the heat inside. At night, open them and let the sun help you warm your house during the day.
3. Weatherstrip around doors and windows to stop air leaks both in summer and winter.
4. Install storm windows if possible. The following diagrams illustrate the difference in heating and cooling load that must be undertaken.



A. Single Window Pane

B. Storm Window or Dual-Pane Window

Note that the temperature difference in Diagram A is 18 degrees F for air conditioning and 36 degrees F for heating. The temperature differential is half as much in both cases in Diagram B, indicating that the furnace or air conditioner will have to work much harder if Diagram A is used.

The Fireplace

1. In the summer, close the damper in your fireplace so cool air will not be drawn out the chimney.
2. In winter, close the damper when not using the fireplace, because warm air escapes.

Lighting

1. You can save by turning off lights you do not need, but lighting uses a relatively small percent of the electricity consumed in most homes. Major appliances and other motor loads use much more electricity than lighting. "Last one out, turn off the lights" will do more to create an attitude favorable to the energy conservation in other high use areas.
2. Choose the right type of lighting. Fluorescent lights are about four times more efficient than incandescent lights, and they last about 9 times longer. While 20 percent of the electricity received by fluorescent is turned into light, only about 5 percent is converted to light in the incandescent bulb.

    a. Fluorescent tubes and fixtures are more expensive to buy than incandescent bulbs with fixtures but are more economical in the long run.

    b. Turning an incandescent bulb off and on will not shorten its life. It will shorten the life of a fluorescent tube. It is better to leave a fluorescent fixture on for an hour than to switch it on and off four or five times during that period.

    c. Turning an incandescent bulb off and on will not consume more energy.

    d. A 40-watt fluorescent lamp produces more light than a 100-watt incandescent bulb at half the energy cost.

3. Use lights in specific work areas instead of lighting the entire room.

4. Use the lowest wattage that will provide the necessary lighting.

5. Lights and appliances create heat. Turn off lights that you are not using.

Do not forget, "last one out, turn off the lights!"

Energy Tips for Heating and Air Conditioning

The air conditioner, the costliest of all appliances in the home in many parts of the country, can be made to serve us at less cost and at a lower energy consumption rate. In choosing a unit, follow the formula below by taking the numbers from the name plate on the back of the unit:

$$\frac{\text{BTU per hour rating}}{\text{Watts input}} = \text{Efficiency Rating}$$

A number from less than 5 to slightly greater than 12 will be derived. The higher the number, the more efficient the air conditioning unit. Also, follow the following tips.

1. Outside, keep plants and shrubs away from compressor units. If air flow is blocked, your system has to work harder.

2. Keep pieces of furniture away from heating and cooling ducts.

3. Nature can help cool the house in the summer and warm it in the winter. Plant shade trees so that shadows fall across the house. Shrubbery near the house also helps block direct sunlight. Both block the cold wind in the winter.

4. To save on heating energy and heating costs: lower the thermostat to 68° during the day and 60° at night. These settings will reduce the temperature an average of 6°, and heating costs should be about 15% less.

5. Setting nighttime temperature back can reduce heating costs significantly. Consider the advantages of a clock thermostat which will automatically turn the heat down at a regular hour before you retire and turn it up just before you wake.

6. Have your furnace serviced once a year, preferably each fall. Adjustment could mean a savings of 10% in family fuel consumption.

7. When buying a new furnace, select one that incorporates an automatic flue gas damper, a device which reduces loss of heat when the furnace is not in operation.

8. If you use electric heating, consider a "heat pump" system. Why? The heat pump uses outside air in both heating and cooling and can save you 60% per year.

9. Be sure that the pilot is turned off in the summer; it can be relighted in winter. Turn it off with the valve. Do not simply blow it out.

10. If the heat or air-conditioner is running, keep the doors closed. Try not to make unnecessary trips in and out of the house.

11. Some outside compressors have unprotected condensers, or at least unfiltered. Check for air flow restrictions caused by grass clippings and other debris. Clean often.

Energy Tips for Kitchens

Currently 20% of our total energy consumption and 30% of our electrical energy is consumed in the home. Since the kitchen consumes a high percentage, consider some of the hints below.

1. Make sure the pilot on your gas range is properly adjusted. It could be using more fuel than it should. Because 10% of our total gas consumption is in the use of pilot lights, consider installing electric pilots.

2. Check the gaskets on your refrigerator, freezer, and freezing compartment doors. If they are worn or ill-fitting, they can allow air leaks, which cause a refrigerator or freezer to overwork and run up operating costs.

3. Replace old and outdated equipment that is using more energy (and costing you more in higher utility bills) than you need to do the job.

4. If you have a self-cleaning oven, use it sparingly. They are large consumers of energy.

5. When selecting your appliances, consider that the numerous options offered do not necessarily make the appliance more efficient, but most require additional energy in order for them to operate properly.

6. Do not take forever to preheat the oven. Generally only 10 minutes is needed. For most dishes, except for baking, there is no need to preheat at all.

7. Avoid oven-peeking. Use cooking aids such as a meat thermometer and time-and-temperature chart to save fuel. Make sure oven door seal is tight and not leaking heated air.

8. Plan oven meals. A complete meal can be cooked in the oven as economically as one food item.

9. When possible use your oven in place of your stove surface units since less heat is lost in confined areas. An electric oven is on for only part of each hour it is used. The rest of the time it "coasts" because its insulation holds heat in.

10. Do not use the oven to heat your kitchen quickly. Oven heat will not circulate efficiently or economically.

11. You can warm foods and plates with retained oven heat and use no additional energy in the process.

12. When baking in glass or glass ceramic, lower the oven setting 25 degrees. These materials transfer heat better than metal.

13. When baking, preheat the oven to the temperature given in the recipe. Place the pans away from the sides of the oven and stagger them so that one is not directly above another.

14. Toasters, waffle irons, skillets, grills, popcorn poppers fondue pots and bean pots use less energy for their specialized jobs than does a range, so use the smaller appliances instead whenever possible.

15. Thaw frozen foods before cooking when practical.

16. Use the minimum amount of water when cooking so it can heat quickly.

17. Use your broiler. Broiler meals save energy. A broiler requires no preheating. With proper planning, a complete meal can be prepared under the broiler.

Energy Tips for Refrigerator and Freezer

The frost-free refrigerator requires 50% more energy to operate than a standard model. Also, the side-by-side refrigerator freezer uses up to 45% more energy than the conventional model. The average size food freezer costs approximately the same as the average frost-free refrigerator. If you really need one (most families do not), be aware that a well-stocked freezer requires less energy to operate than a partially full one.

The refrigerator and freezer operate around the clock. Given proper care and use, they can provide major energy savings.

1. Let foods cool to room temperature before placing them in the refrigerator or freezer unless the recipe calls for placing hot foods immediately in the refrigerator.
2. Choose a refrigerator or freezer according to the capacity needs of your family.
3. A freezer or refrigerator operates more economically when filled to capacity but not overfilled.
4. A refrigerator or freezer should not be set to run colder than necessary. Follow the manufacturer's recommendations.
5. Be sure doors are always closed firmly and kept open no longer than necessary to remove or store foods and beverages.
6. Defrost your freezer or freezing compartment when frost is no more than 1/4 inch thick. Frost decreases efficiency. Your refrigerator or freezer works harder to maintain the same temperature.

Energy Tips for TV and Radio

1. When no one's watching TV or listening to the radio or stereo, they may as well be off, conserving electricity. If a TV is continually turned off and on, heating and cooling the tubes again and again wears them out. Therefore, if there is a short interval between something you want to watch, leave the set on.
2. In choosing entertainment equipment, remember that solid-state equipment has no tubes to heat or cool, therefore, less energy will be consumed during operating hours.
3. If you have an instant-on TV, unplug it when it is not going to be in use for an extended time or during a vacation. Better yet, choose a set without the instant-on feature and save energy.
4. Choose the smallest TV screen that will allow entertainment. Larger screened sets use more energy.

General Tips

Some energy tips are just good household economics. Try these:

1. Buy milk and soda in returnable containers. Three purchases in returnable containers can be made before an amount of energy is consumed to equal a purchase of no-deposit no-return containers.

2. Buy toys that are solidly constructed. Energy consumed in the manufacture of cheaper toys is essentially the same as better, but more costly ones.

3. Buy items made from recycled materials. Energy required to recycle is far less than to process the same materials from virgin stock. Aluminum, for example, takes 20 times more energy to make from bauxite ore than from aluminum stock.

4. Support your recycling center by bringing materials to be recycled. If you do not have one, see about starting one.

5. Urge your stores to stock recycled items, then buy them.

6. Read by windows. Natural light is better for your eyes anyway.

7. Close doors and registers of rooms (such as a guest room) which are seldom used.

8. Try not to jiggle your thermostat; this will not make your heating system more efficient as some people believe. In winter, try to keep the normal thermostat setting no higher than 68 degrees--once you pass this point, your heating costs and energy consumption rise significantly.

9. If you are going to be away for the weekend, lower the thermostat about 10 degrees. But if you plan a winter vacation for longer periods of time, lower the thermostat to 50 degrees.

10. Moisture in the air will keep you more comfortable in winter with a lower thermostat setting. House plants give off moisture and help you maintain proper humidity levels indoors. A humidifier, if needed, is a wise investment.

11. Gas dryers - never use the dryer unless it is full, but never overfill. On nice days think about hanging your clothes outside; you will surprised at how fresh and clean they smell.

12. Hot water heater - check the thermostat setting. It should be set at 140° or on "normal." Also, check for leaky faucets, especially hot water leaks. One drip a second can waste up to 700 gallons of hot water per year and waste the energy that was used to heat it. Take showers instead of tub baths; you will use less hot water this way.

ACTIVITIES

1. Form car pools (Activity VIII-1).
2. Complete car pool puzzle (Activity VIII-2).
3. Unscramble energy conservation words (Activity VIII-3).
4. Complete pollution maze (Activity VIII-4).
5. Complete activity problems (Activity VIII-5).
6. Complete fuel conservation experiment (Activity VIII-6).
7. Complete "Name a Car Word Puzzle" (Activity VIII-7).
8. Complete checklist for efficient automobiles (Activity VIII-8).

Forming Car Pools in Your Class

(Activity VIII-1)

1. Obtain a large map of your community.
2. Using a pen or colored pencil, have each student locate his home on the map.
3. Have the students study the locations of the homes on the maps and group the locations for possible car pools.
4. Have a class discussion about car pooling. Ideas for discussion might include: How does car pooling save energy? Would car pooling reduce tardiness? Would car pooling encourage community involvement?
5. Encourage the students to convince their parents to form local car pools for work and school.

Car Pool Puzzle

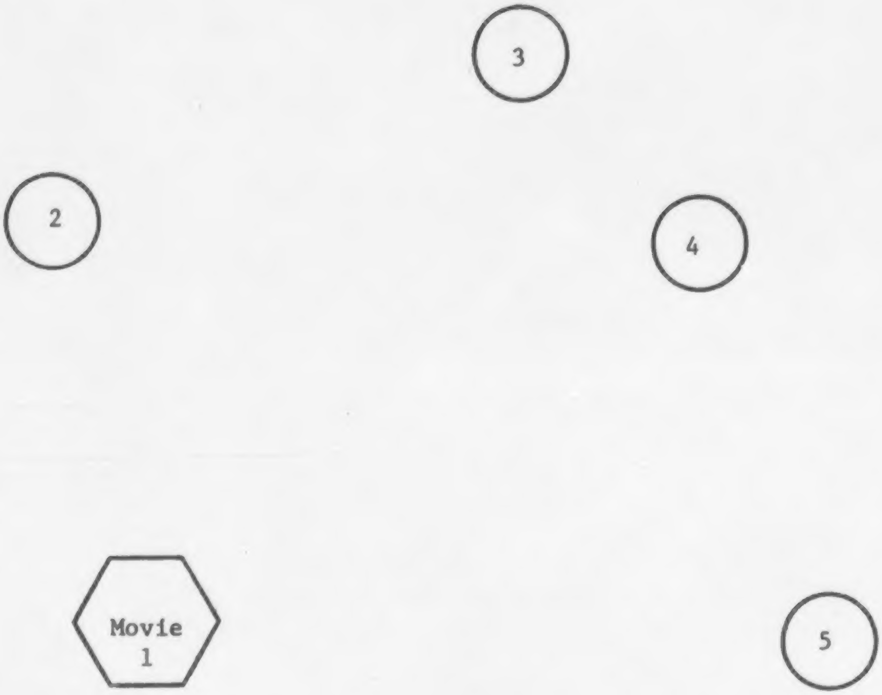
(Activity VIII-2)

Problem

Get all the people to the movie by having cars travel the shortest distance, thus saving energy. You may use as many cars as you wish. Remember, all the cars must return home.

1 to 2 = 1 mile
1 to 3 = 4 miles
1 to 4 = 3 miles
1 to 5 = 4 miles
4 to 5 = 3 miles

2 to 3 = 2 miles
2 to 4 = 3 miles
2 to 5 = 5 miles
3 to 4 = 1 mile
3 to 5 = 4 miles



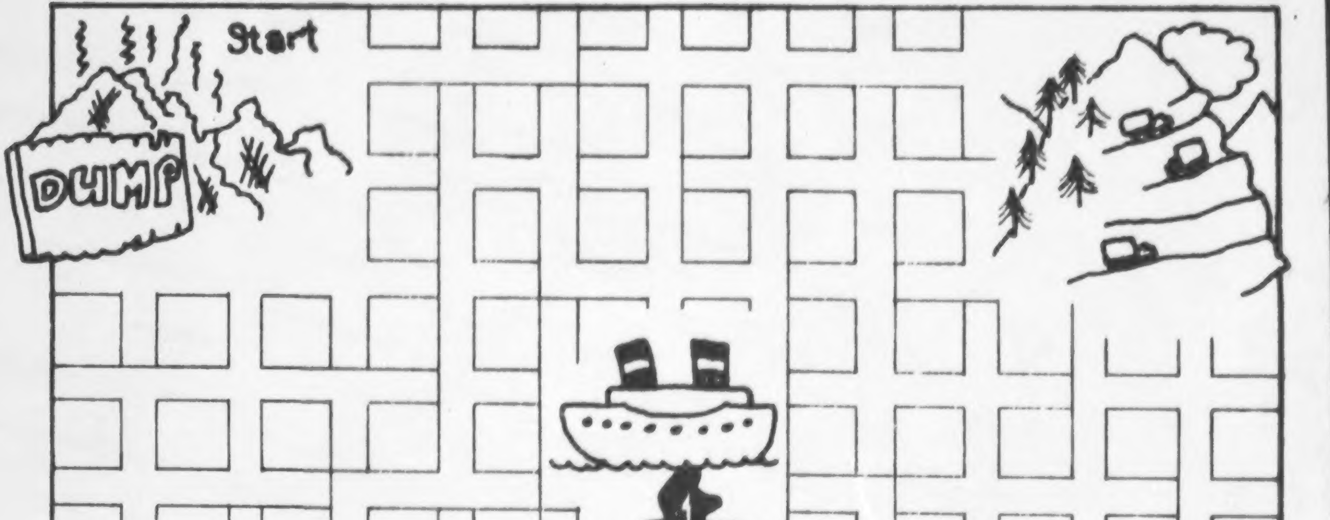
How Many of These Energy Conservation Words Can You Unscramble?

(Activity VIII-3)

1. lenucar
2. ionsfu
3. dhgenyro
4. lsaro
5. terdeium
6. unanimr
7. bcaonr
8. ummtopi
9. uptromeel
10. eesarrhc
11. isinhdiming
12. ailsdertnei
13. laicremmoc
14. tasheorg
15. caifqulitioni
16. erngye
17. cikneti
18. thealogerm
19. iaraitdon
20. earlhtm

Activity VIII-4

DIRECTIONS: If you can get to the bottom of this maze, you will reach the land of clean air and water. Start at the garbage dump and avoid the polluters that use the most fuel.



Activity VIII-5

1. Lower the thermostat to 68° during the day and 60° at night for the best combination of comfort and savings. If these settings reduce the temperature an average of 6°, heating costs should run about 15% less. What percentage of savings would actually be saved if all homes lowered their thermostats 2°?

   ____

2. If the 6° save enough electricity to heat 9 million homes during the winter season, how many could be heated by a 2° thermostat change? ________________________________

3. Setting nighttime temperature back can reduce heating costs significantly. Consider the advantage of a clock thermostat which will automatically turn the heat down at a regular hour before you retire and turn it up just before you awake. If this saves 30% on nighttime heat, what would be saved in kw hours a year if you save 40 kw hours a week? ________________

4. When buying a new furnace, select one that incorporates an automatic flue gas damper, a device which reduces loss of heat when the furnace is not in operation. If this saves 25%, what would be the savings in money four weeks if you save 10 gallons per week of propane at 37¢ per gallon? ____________

5. If you use electric heating, consider a "heat pump" system. The heat pump uses outside air in both heating and cooling and can cut the use of electricity for heating by 60 percent. What would be the cost of your bill with the above pump if your bill had been $100 without the pump? ____________________

6. How many watts are required to run a 10 amp motor for one hour on a 110 volts circuit? ________________________

7. Figure the cost of running the above motor for two hours at a cost of 4¢ per kilowatt hour - (1,000 watts = 1 kilowatt) - to nearest penny. ______________________________

Fuel Conservation Experiment

(Activity VIII-6)

Procedure:

1. Disassemble, repair, and reassemble an engine. Leave the points .005 wider than normal.
2. Tune and operate the engine.
3. Remove the fuel tank and air cleaner.
4. Remove the nylon check valve assembly.
5. Install the plastic adapter and brass fittings.
6. Attach the "visible fuel use gauge" to the carburetor with a piece of plastic hose.
7. Slowly fill the tube with gasoline.
8. Start the engine; open throttle about ½ way.
9. Apply tachometer and maintain 1600 RPM during all tests.
10. Use a grease pencil to mark the location of the gasoline as a 30 second time interval begins.
11. Maintain constant RPM and mark where the gasoline is after 30 seconds.
12. Stop the engine.
13. Measure the distance the gasoline moved and record on the student lab sheet. (test 1)
14. Open the high-speed needle valve ½ round.
15. Start the engine and operate at the same RPM as in the first test.
16. Mark and time as in the first test.
17. Record your results as test 2.
18. Replace the air cleaner and test again. Record the results as test 3.
19. Adjust the carburetor needle valve to maximum efficiency.
20. Adjust the point setting to normal.

21. Run the three tests again; label them as tests 4, 5, and 6.

22. Close the high speed needle valve.

23. Remove the "visible fuel use gauge" and hose.

24. Attach the propane bottle and regulator.

25. Open the throttle to about ½ turn.

26. Open the propane bottle and adjust the regulator to deliver 2½ pounds pressure.

27. Open the needle valve one round and start the engine. If the engine fails to start, open the needle valve another ½ turn and try again.

28. The engine speed may be changed by changing the regulator setting.

29. Turn off the propane bottle and allow the engine to run until it stops.

30. Replace the fuel tank and clean up your area.

Lab Sheet for Activity VIII-6

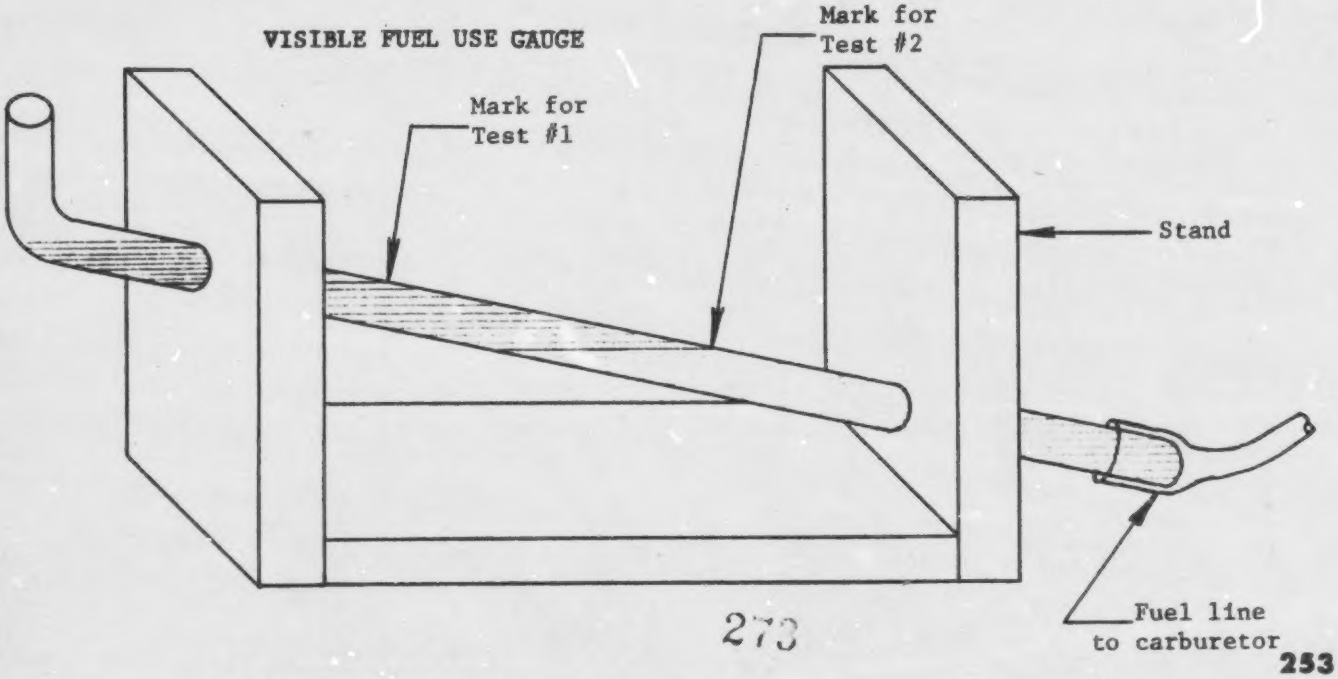
Test #	RPM	Gas Flow Inches	Engine Condition
1			Tuned, Points .005 wide
2			Rich Mixture-Needle Valve, Points .005+
3			Rich Mixture-Air Cleaner, Points .005+
4			Tuned, Timing correct
5			Rich, Needle valve, Timing correct
6			Rich, Air Cleaner, Timing correct

1. The percentage of difference between the worst and the best results ____________________%. State your conclusions concerning how fuel consumption is affected by proper tuning of the engine.

2. What percentage of our nation's oil is used as auto gasoline? ____________________%.

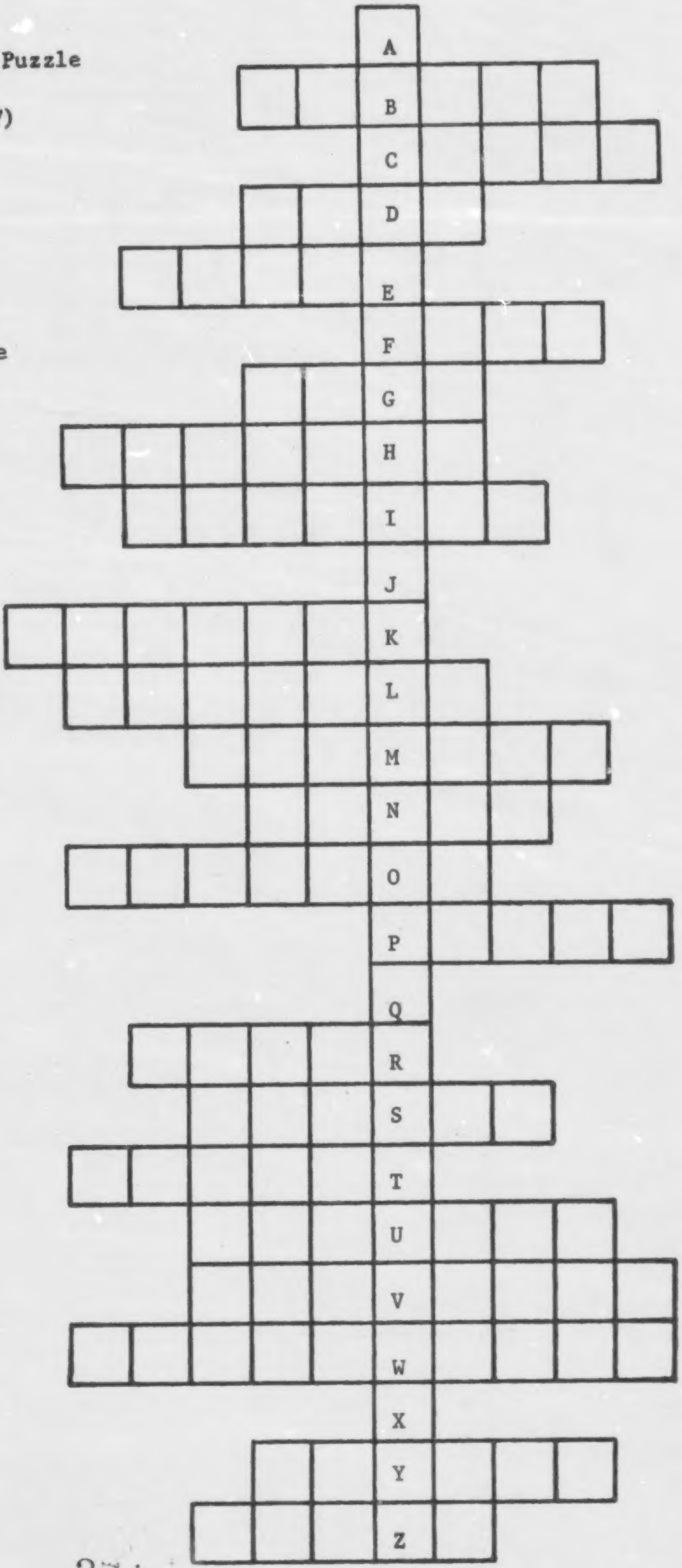
3. Proper engine maintenance could result in saving what percent? ____________________%.

VISIBLE FUEL USE GAUGE



Name the Car Word Puzzle

(Activity VIII-7)



Use the list of cars below to fill in the boxes on the right. Each car has a place in the puzzle. How many families in your class own a car the list below?

Cars with E.P.S. combined (city/hwy) fuel economy of 20 mpg or better:

AUDI
FIAT
VEGA

ASTRE
CAPRI
HONDA
MONZA
PACER
PINTO

BOBCAT
DATSUN
SUBARU
TOYOTA

GREMLIN
PEUGEOT
PORSCHE
RENAULT
SKYHAWK
SUNBIRD
TRIUMPH

CHEVETTE

VOLKSWAGEN

Checklist for Efficient Automobiles

(Activity VIII-8)

It is less expensive to drive and to maintain a car that is well cared for. You also save energy and reduce air pollution. Know how to determine when your car's efficiency is lower than it should be. Follow the checklist below and check off each danger signal. Let your parents or an older brother or sister help you.

☐ Car creeps ahead abnormally when stopped with automatic transmission in gear.

☐ Engine does not stop when key is turned off.

☐ Engine has intermittent or rough idle.

☐ Tailpipe has dark deposit inside and/or the back of the car is discolored in that area.

☐ Engine stalls frequently or is hard to start.

☐ Acceleration is sluggish.

☐ Engine misfires.

☐ Gas or oil odor is detectable inside the car.

☐ Engine knocks and pings.

☐ Unusual oil consumption, and

☐ Obviously, poor gas mileage.

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide a comprehensive set of energy saving tips. The chapter is divided into seven major areas of conservation: in the car, building and design of a home, heating and air conditioning, kitchen, refrigerator and freezer, and general tips. Chapter 8 also serves as a basic text for the next unit.

Seven of the eight activities are designed as individual projects. The harder activities could be used for extra credit or for advanced students. The "Fuel Conservation Experiment" has been successfully completed by a junior high automotive class. It can be demonstrated to other interested classes or used as a display. Have a conservation contest or see if the class can add to the list of energy saving tips.

This chapter is not involved, and with the exception of the activities, it could be used as a resource chapter.

List of Materials

Activity VIII-1

film "The Environment"

film projector and screen

Activity VIII-2

community map

pen or colored pencil

Activity VIII-3

pencil or pen and paper

hand-out

Activity VIII-4

hand-out

pencil or pen

Activity VIII-5

hand-out

pencil or pen

Activity VIII-6

pencil or pen and paper

Activity VIII-7

Briggs & Stratton Manual,

tools and engine

plastic fuel adapter with brass fittings

6" plastic hose

small funnel

gasoline

a watch with second hand

grease pencil

propane bottle

torch adapter hoses and regulator

tachometer

Student Lab Sheet (hand-out)

Activity VIII-8 and 9

hand-out, pencil or pen

TEST

TRUE OR FALSE: Mark each statement by circling a "T" or "F". If the statement is false, correct it and make the statement true.

T F 1. Radial tires help save fuel, last longer and are safer than bias tires.
*

T F 2. Quick stops save gasoline.
   *

T F 3. Driving at 70 mph uses more gasoline than driving at 55 mph.
*

T F 4. Car pools of three persons can save more than 260 gallons per year for each of the three people.
*

T F 5. Seventy-five percent of heat and air conditioning is lost through windows.
   *

T F 6. Trees aid in cooling your house in summer.
*

T F 7. A fireplace can be a source of cool air during the winter.
*

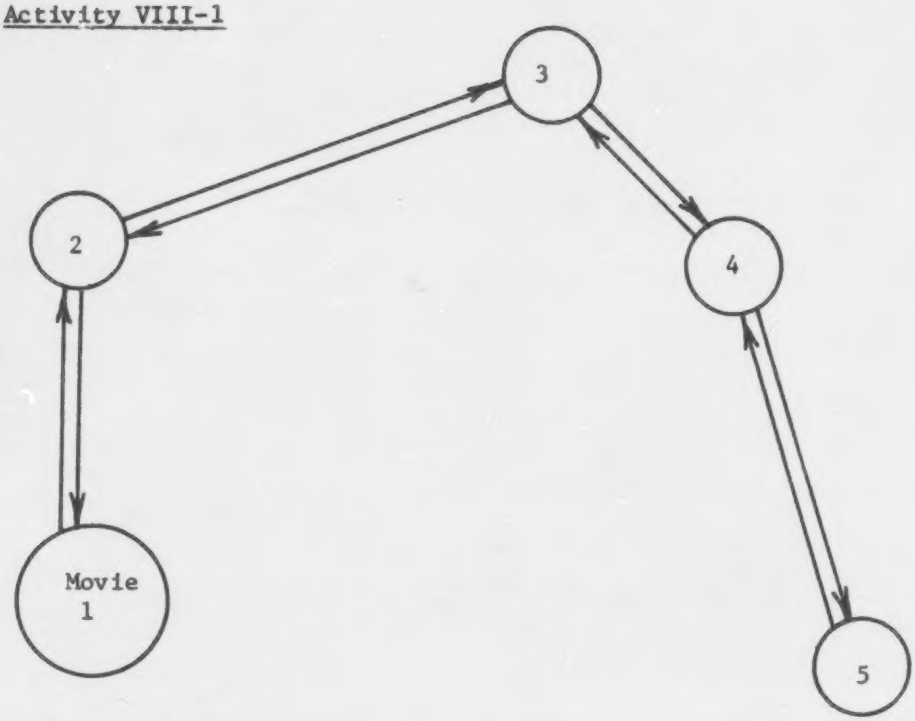
T F 8. Incandescent lights are more efficient than fluorescent lights.
   *

T F 9. Fluorescent lights last nine times longer than incandescent lights.
*

T F 10. In winter, reducing your thermometer to 68° during the day and 60° at night saves in heating cost and energy.
*

Answers: Activities VIII-1, 3 & 5

Activity VIII-1



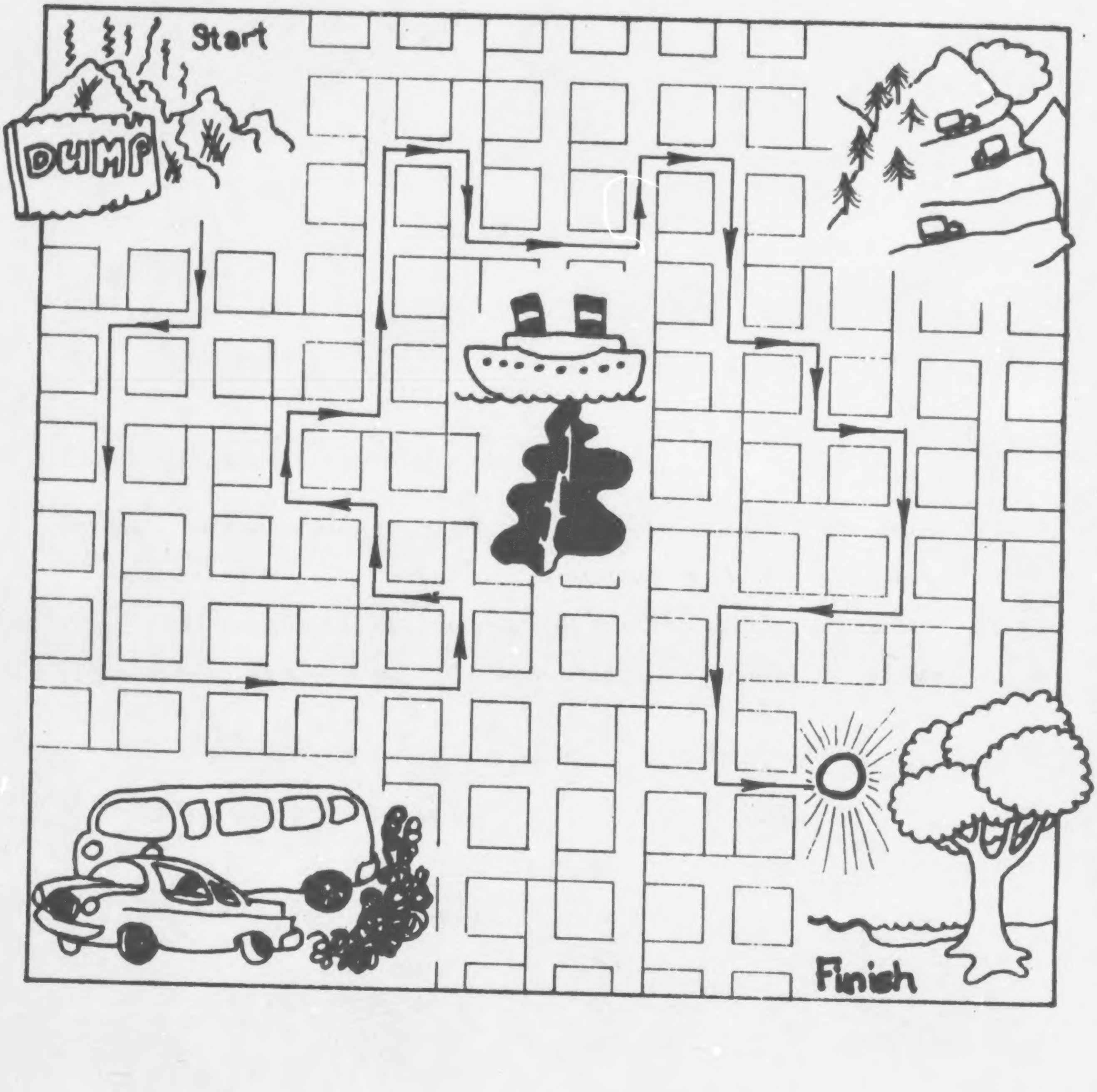
Activity VIII-3

1. nuclear 2. fusion 3. hydrogen 4. solar 5. deuterium 6. uranium
7. carbon 8. optimum 9. petroleum 10. research 11. diminishing
12. residential 13. commercial 14. shortage 15. liquification
16. energy 17. kinetic 18. geothermal 19. radiation 20. thermal

Activity VIII-5

1. 5%
2. 3 million
3. 2,080 kwh
4. $15,000
5. $40.00
6. 1,100 watts
7. 9 cents

Answer: Activity VIII-4


Start
DUMP
Finish

Information for Activity VIII-7

This activity is designed to give visual proof that an untuned engine wastes fuel. This activity uses a 3.5 horsepower Briggs and Stratton engine.

Three students will disassemble, repair, and reassemble a small engine using the Briggs and Stratton Repair Instruction III Manual, form MS-4750-48. Included in the manual are general theories of operation, disassembly, repair, reassembly, and tune up procedures. The information in the manual applies to any small gasoline engine which may be available for classroom use.

The first step should be for the students to set the points .005 wider (or more narrow) than normal. This should de-tune the ignition timing. As the engine operates, the points will become more narrow.

The students will then make six tests on the engine, record their results on the lab sheet and draw conclusions concerning fuel consumption resulting from the operation of the engine.

When working with carburetors which do not have a float and needle valve, the fuel flow tube must be mounted at such an angle that the top of the gasoline will never be above nor below the limits imposed by the gasoline tank which came with the engine. Gasoline above this limit will flood the engine; gasoline below this limit will "starve" the engine. Some variation in engine speed will occur as the gasoline level changes; however, this can be controlled by the students during testing.

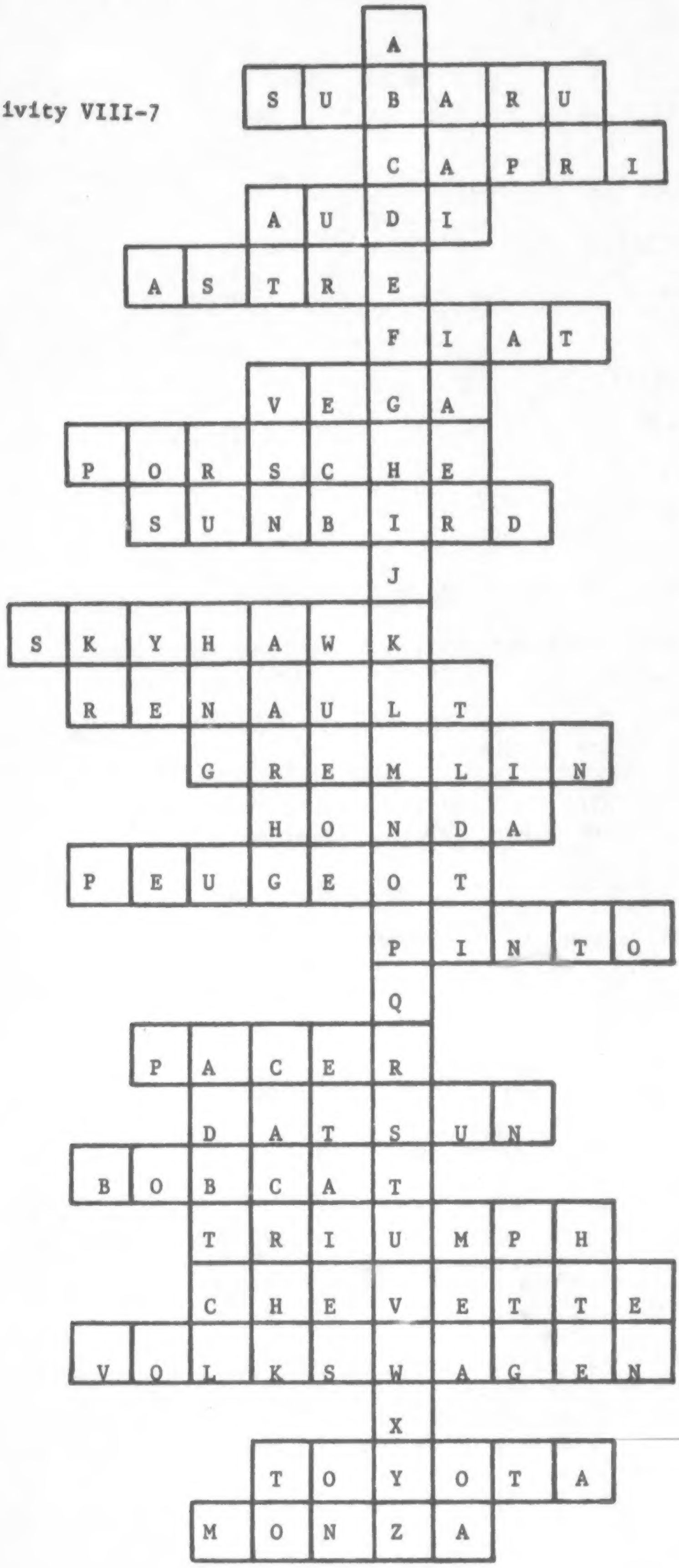
A vertical flow tube shows the fastest rate of change in fuel level and may be used with float-type carburetors. With all other carburetors the most-nearly vertical position for the flow tube should be chosen.

During testing, each of the three students has a particular job. One student holds the tachometer and controls the throttle. One student times the 30 second test with a watch. One student marks the start and stop of the test with a grease pencil. At the end of the test the length of fuel movement is recorded.

Although the "visible fuel use gauge" is glass, flexible plastic tubing (mounted on a board to prevent sag) is recommended for the classroom.

Small engine tests will not give the same results as auto engines; the main fuel jets on autos are not adjustable. The students will connect a propane bottle and run the engine. A small regulator will supply propane continously. Large, sensitive regulators are required for operation similar to that of a tractor or other engine. Propane is only one alternative to oil and gasoline fuels. Scientists are experimenting with many other kinds of fuels including butane, methane, methonal, and kerosene.

Answers: Activity VIII-7


A
SUBARU
CAPRI
AUDI
ASTRE
FIAT
VEGA
PORSCHE
SUNBIRD
J
SKYHAWK
RENAULT
GREMLIN
HONDA
PEUGEOT
PINTO
Q
PACER
DATSUN
BOBCAT
TRIUMPH
CHEVETTE
VOLKSWAGEN
X
TOYOTA
MONZA

RESOURCE LIST

Publications (Books)

General Theories of Operation. Briggs & Stratton Corp., Milwaukee, Wis.

Repair Instructions III. Briggs & Stratton Corp., Milwaukee, Wis.

Pamphlets and Journals

"Auto Efficiency Check Lanes," The Chapter Service Center, The United States Jaycees.

"Does Your Car Eat Too Much?," Cooperative Extension Service, Michigan State University.

"Energy and You," *All Hands,* V. 683, December 1973, pp. 44-45.

"Energy Conservation. . . Some Wheat, Some Chaff," *American Gas Association Journal,* V. 55, February, 1973, p. 4.

"Energy Saving Tips for Drivers," Agricultural Extension Service, University of Minnesota.

"Energy Tips for Automobile and Transportation Efficiency," The United States Jaycees, Tulsa, Oklahoma.

"Gas Watchers' Guide," American Automobile Association, Falls Church, VA.

"Getting the Most from Every Drop," Texas Department of Agriculture.

"Individual Action for Energy Conservation," U.S. Government Printing Office, Washington, D.C.

"Natural Gas Energy and the Environment," Natural Gas Energy Newsletter, Vol. Z, No.1.

"99 Ways to Conserve Energy," *Soldiers,* V. 29, January 1974, pp. 48-49.

"Out of Energy Saving Ideas--Here are Some Epic Suggestions," *Conservation Today,* V. 4, September 6, 1974, pp. 5-7.

"Save Energy and Save," Governor's Office, Division of Planning Coordination, Austin, Texas.

"The Campaign to Conserve Energy," *American Gas Association Journal,* V. 55, June 1973, p. 8.

"The Energy Saving Guide Book," Electrical Industries Association, Los Angeles, California.

"Thirty-one Fuel Crisis Responses for Adult Higher Education to Meet Consumer (Student) Needs," Adult Leadership, V. 23, June 1974, p. 53.

"Tips for Energy Savers," Federal Energy Administration, Government Printing Office, Washington, D.C., 1975 (0-0566-806).

Slides

"Fuel Consumption Testing"

ENCORE

Chapter 9

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. name and describe the six types of solar collectors.
2. construct a solar cooker.
3. verbally review the history of solar energy and the use of solar energy by pueblo and cliff dwelling indians.
4. follow a diagram of a compression-refrigeration unit.
5. discuss the possibilities of solar energy for the future.

SOLAR ENERGY

Many years have elapsed since the Greeks worshiped the sun god Helios (Apollo), and the Egyptians worshiped RA, the god of gods. Many early cultures founded entire religions on the sun, and the sun reigned as their supreme god for thousands of years. No other heavenly body has ever been worshiped as much as the sun (see Figure IX-1).

FAMOUS SUN GODS

HELIOS	GREECE
RA	EGYPT
BAAL	PHOENICIA
MITHRAS	PERSIA
AMATERASU OMIKAMI	JAPAN
TONATIUH	MEXICO
VISHNU	INDIA

FIGURE IX-1

Even before the sun became the supreme god, cavemen used the sun for warmth. Just how far the caveman's mind had developed is not known, but it is known that he selected caves with openings in the direct path of the sun to warm his dwelling. Little did the caveman know that each hour the sun supplies an equivalent of 21,000,000,000 tons of coal or 160 KWH's per year per square foot. That is enough energy delivered to a 10' X 14' panel to produce 22,000 KWH/year--all the power needed to operate an air-conditioned, all-electric home.

The caveman probably did not realize that the sun that warmed his dwelling was also giving energy to plants for growth. The process (photosynthesis) by which plants combine water and carbon dioxide uses sunlight and results in plant growth. This energy is stored in the plants. When animals eat the plants, they recover the stored energy. The stored energy can also be found in coal, natural gas, or oil. Today, the sun's energy is responsible for the winds, tides, ocean currents and rivers.

The fable of Archimedes burning the Roman fleet in 212 B.C. was one of the earliest attempts to harness solar energy. The fable suggested that Archimedes set the fleet afire by using "burning mirrors moving every way upon hinges which when placed in the sun's direct rays directed them upon the Roman fleet so as to reduce it to ashes at a distance of a bowshot" (AIA Research Corp., p. 9). Even though this actually may not have taken place, the fable tells us that man realized how powerful the sun really was.

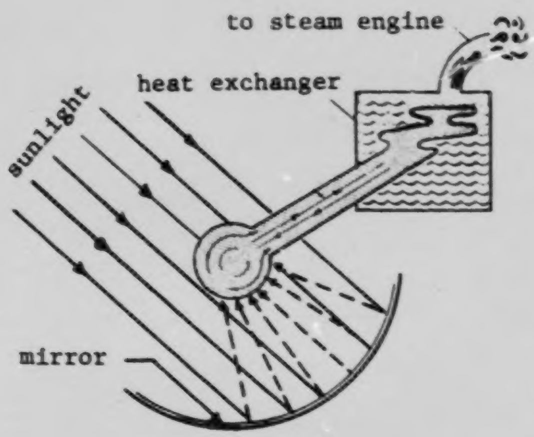
The focus on sun worshiping changed about 1600 A.D. and began to move from superstition and magic to science. The Renaissance brought many solar devices. During this period a "solar engine" was invented by Solomon de Caus, a Frenchman. The sun was used to heat air in his "solar engine" to pump water. It was a simple machine, but it was not reinvented for almost 200 years.

The 18th century produced the first solar furnaces. The furnaces were used throughout Europe and the Middle East. Another French scientist, Antonie Lavoisier, constructed a furnace with a 52 inch lens plus an eight inch second lens and reached the temperature of 3182°F (1750°C). Higher temperatures were not produced by man until 100 years later. Presently, a U.S. aircraft manufacturer studying various metals and ceramic materials uses the largest solar furnace in the United States. The collector for the furnace is a 120 inch aluminum mirror that focuses the rays to a dime-sized point. Under ideal conditions the furnace can develop temperatures exceeding 8500°F. An oxyacetylene torch produces temperatures of 6000°F.

The 19th century proved to produce more solar engines. They were used to power everything from printing presses at the Chicago World's Fair to distilling units and electric lights.

Most 18th century solar devices used central focusing collectors where the sun's rays were focused on to a central point to collect the energy. Early during the 19th century "flat-plate" collectors were being used. This type of collector did not focus the sun's rays onto a central point, but collected the energy over the entire area. The "flat plate" collector had advantages over the central focusing collector because: it was less expensive; it could operate under cloudy skies; it was simplier in construction. Both types of collectors were used later during the 20th century where they were used in solar powered pumping stations in the United States.

In 1901 A. G. Eneas devised a solar-powered pump using water as a medium. He used 1,788 mirrors to focus the sun's rays on a small boiler. The steam formed was used to drive the pump. A more developed steam-powered plant was devised by Dr. Abbot of the Smithsonian Institute in the 1960's. (see Figure IX-2).



mirror - type collector

The power plant used the mirrors to focus the sunlight on a central point. Fluid circulated through the focal point and removed the heat to a heat exchanger. In the heat exchanger the heat was transferred to the water and steam formed. The steam was used to drive a small steam engine. The steam engine operated a small generator and produced electricity. The sunlight steam-operated engine produced from 2 to 5 horsepower.

Another development during the early 20th century was Shuman's flat-plate collector and 2.5 horsepower engine. The engine was predicted to reach 100 horsepower, but due to inclement weather he fell short of his predictions.

Solar energy ideas were expensive and fossil fuels were more abundant during this time; therefore, only a small amount of work with solar energy continued. Presently, the energy crisis has revived solar energy research.

Heating and Cooling

An observation of the pueblo indians revealed that the pueblos' dwellings were outstanding examples of the early use of solar energy. The climate in the Southwest is hot and dry with high daytime temperatures and low nighttime temperatures. The pueblo indians used adobe, mud and stone to insulate their dwellings during the day and as a source of heat during the cold nights. The adobe was thick enough that it absorbed the heat and kept the dwelling cool during the day. By building the dwellings on top of each other and by using very few windows in the dwellings, maximum cooling was allowed. The few windows did not permit hot outside air to circulate through the houses and heat up the interior. Stacking the houses reduced the outside surface area to be heated by the sun and therefore, less heat was absorbed. Because of the thickness of the adobe walls, they held the heat and released it at night to the interior and kept the dwellings comfortable. The cooking areas were separate rooms; therefore, less heat was released into the dwelling. The cliff dwellers of Arizona also used these basic solar design principles. Montezuma's castle was built in 1100 A.D. It was built to absorb the direct solar radiation on a wall facing the South. And this heat was used late in the evening similar to the pueblos' dwellings. The major difference in the cliffdweller's and the pueblos's dwellings is that the cliffdwellers used the high overhang of the cliff to protect them from the intense noonday heat.

Solar Heating and Cooling

Solar Heating became popular about the 1930's and 40's because there was no inexpensive fuel sources like natural gas. Again, residents are using solar-heated water. It is estimated that there are 50,000 solar-heated homes in Florida alone. How are these systems constructed and maintained?

Basically, any solar energy system must have: a collector, storage and a distribution system. The solar collector is a device for converting solar radiation to either electrical or thermal energy. Thermal energy collectors may be focusing or non-focusing, and they use water or air to transport the solar heat. Electrical energy collectors may use thermoelectric or photoelectric methods of direct electrical energy production. There are two types of photoelectric cells--the thin wafer single crystal silicon type and the thin polycrystalline cadium sulfide type. Of the two types mentioned, the silicon is considered more advanced. The space programs have used this type for direct electrical production for over a decade. The major disadvantage of the silicon cell is the cost! Cadium sulfide was originally used as a pigment in paint, but now it is used in crystalline form to convert light energy directly to electricity. Electrodes can be attached to opposite sides, one electrode made of silver and the other of indium. The electrodes are connected to a motor to complete the circuit. Sunlight strikes the crystal and induces an electrical current. The electrical current is transported to the motor where the electrical energy is changed to mechanical. A thin cadium sulfide crystal 4' X 14' built on a rooftop can provide enough electricity to power all the lights, stove, refrigerator and appliances in a house.

The silicon cell works similarly. Under favorable conditions the cell can produce about 90 watts with a surface area of about 50 square inches.

The thermal converter (absorber) is another type of collector used for the purpose of indirectly heating or cooling of the home with solar energy. These types of collectors are relatively inexpensive and can be constructed at home.

Storage was the second necessary part of a solar energy system. The storage component (reservoir) is capable of storing thermal energy. Rock, concrete, water and many other elements can store the heat that is collected and re-radiate the heat where needed. For example, greenhouses can easily be heated during winter months by placing 55 gallon drums of water inside the greenhouse. The heat given off from the barrels is enough to keep the temperature comfortable. Other elements that can be used are those that store heat in the form of chemical change.

Distributing the stored heat was the third necessity in a solar energy system. Water can carry the heat throughout the house from home heating purposes and can also be a supply of hot water for washing. Another medium used often is air. A simple fan can move the air and there is plenty of air available.

Other parts that may be necessary in a solar energy system are transport, auxiliary energy and control components.

Collector Types

Solar collectors can be constructed in various forms according to the medium used to transport the heat. The flat-plate collector can be used in most situations; they are very versatile. Temperatures of 250°F can be reached with the flat-plate type collector. The flat-plate collector is a box with a clear cover sheet. The base is usually painted black to absorb the sun's energy. Insulation is put under the black base so less heat escapes. Water or air is used to transport the heat to be stored in rocks, concrete, water or other storage elements. The heat can also be used directly for heating the air in the house (see Figure IX-3).

Open water collectors are a type of flat plate collector. The open water collector uses corregated metal as a base collector plate. The water travels down the valleys of the collector, absorbs heat and then flows to a gutter where the water is transported for use or storage (see Figure

IX-4). One disadvantage of the open water collectors is that the water will freeze when the temperature drops.

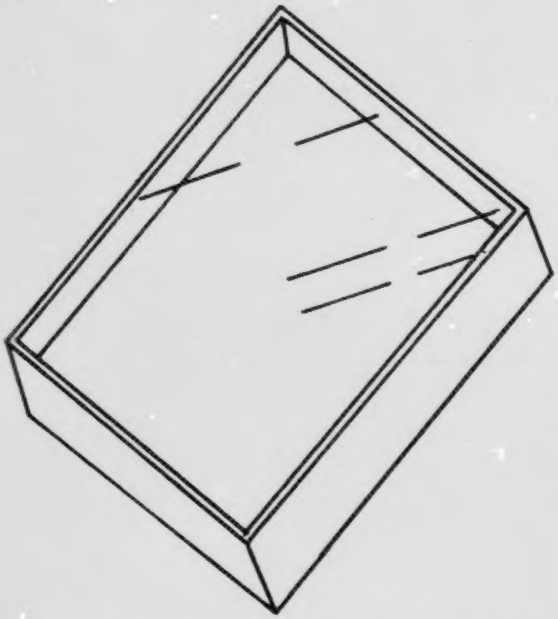


Figure IX-3

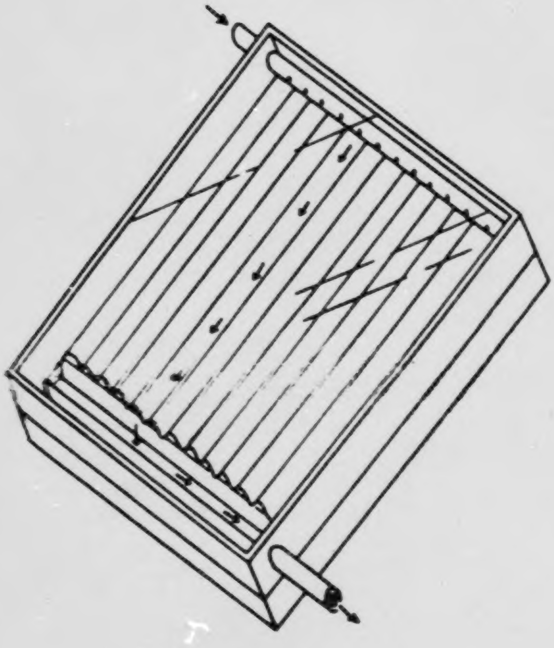


Figure IX-4

The air-cooled flat plate collector uses air to transport heat. The air passes over the heated surface, removes the heat, and transports it to a storage location. The system is inexpensive and maintenance is not required. However, it is inefficient and requires large ducts to transport the required amount of air for proper heating (see Figure IX-5).

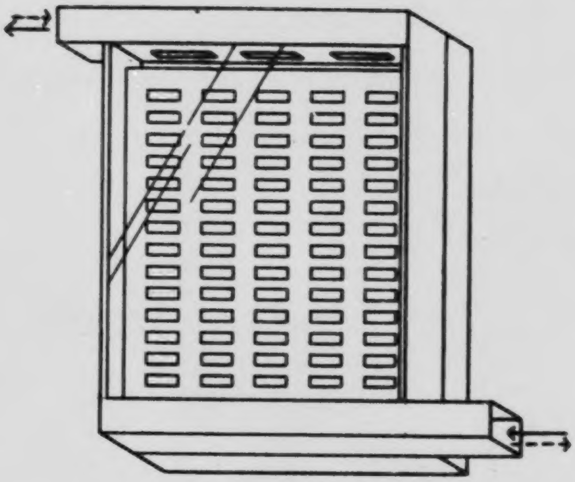


Figure IX-5

The liquid cooled collector uses liquid such as water or an antifreeze solution to transport heat. The liquid passes through absorber tubes in the collector and removes the heat. The major problems surrounding the liquid cooled collector is trying to keep is from freezing, leaking and corroding (see Figure IX-6).

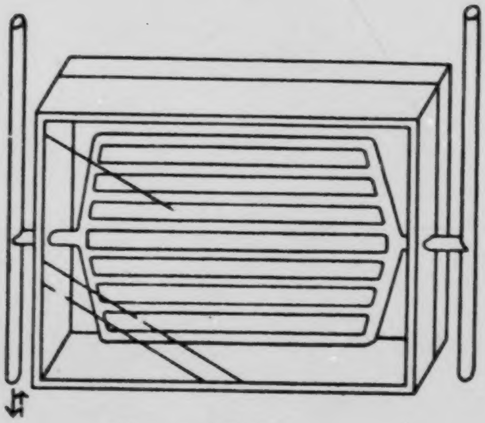


Figure IX-6

Flat-plate collectors are generally mounted on rooftops or on the ground and tilted at a certain angle to collect the greatest amount of solar radiation. A rule of thumb for the proper angle is to add 10° to the latitude of the collector. For the best results, a tracking device that constantly follows the sun's rotation would provide more energy than the basic non-tracking type collector; however, it is costly.

Concentrating collectors are also used. The purpose of concentrating collectors is to focus the sun's rays on a small point or tube. It is similar to a magnifying glass that focuses the sun's rays to create high temperatures. The linear concentrating collector focuses the energy on a tube filled with a transport medium which collects the heat. The linear concentration looks like a feed trough that can be tilted to the proper angle (see Figure IX-7).

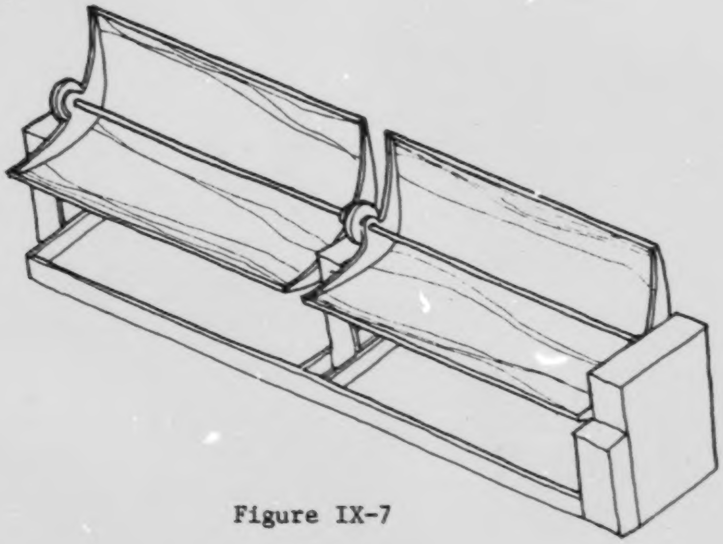


Figure IX-7

The circular concentrating collector has a dish shape and concentrates the sun's rays on a small central point. The absorber collects the heat and the heat is removed by a transport fluid. The unit is normally made to follow the sun. High temperatures have been achieved with this type of collector (see Figure IX-8).

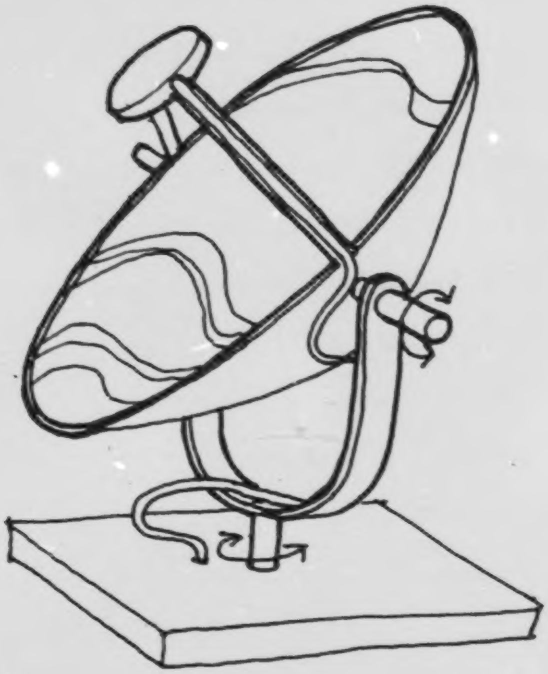


Figure IX-8

Solar Cooling

It may be somewhat hard to believe that solar energy could be used to provide cooling during hot summer days, but it can. To understand how solar energy can provide cooling to a house or business establishment, you must understand some basic principles about air conditioning and refrigeration. The basic air conditioning-refrigeration cycle using a compression refrigeration unit is shown in Figure IX-9.

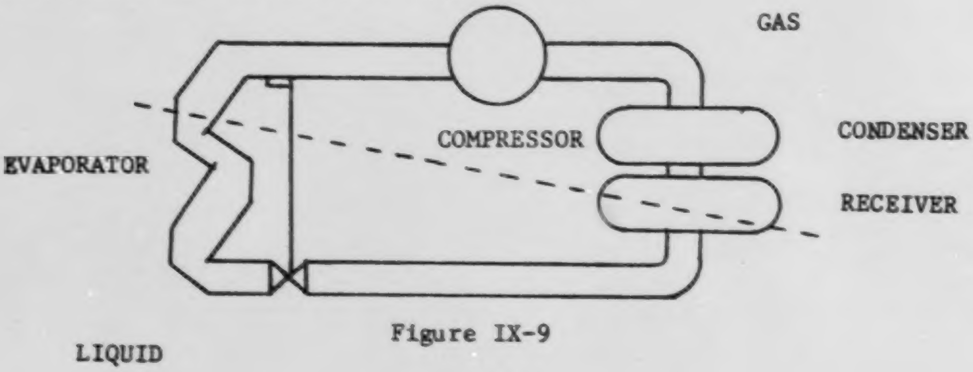

GAS
COMPRESSOR
CONDENSER
EVAPORATOR
RECEIVER
LIQUID

Figure IX-9

As you can see the cycle is divided; one side is the liquid side and the other is a vapor side. Since most liquids cannot be compressed, vapors have to be used in a compressor. The primary reason, however, is because more heat is transferred when a liquid changes to a vapor than at any other time.

Heat energy is measured in BTU's. One BTU will raise the temperature of one pound of water one degree. When we change water from solid (ice) at 32°F to a liquid at 32°F it takes 144 BTU's of energy. Therefore, one BTU is required for every 1°F of temperature up to 212°F (total 180 BTU's from 32°F liquid to 212°F liquid). To change the liquid at 212°F to steam at 212°F it takes 977 BTU's. So, it can be seen that there is more energy transferred during the change of state from liquid to steam (or vapor). Refrigeration units do not normally use water because water has a tendency to freeze. Other refrigerants such as R-12, R-22 and R-114 have very low freezing points and are used more commonly.

To understand solar cooling, we also need to understand the relation between boiling points and pressure. If we went to Denver, Colorado we would find that the pressure is lower and water boils at about 195-200°F instead of 212°. All liquids follow this rule.

Now let's trace the refrigerant through the refrigeration cycle. Liquid enters the expansion valve. The liquid is under high pressure because it has been compressed before it entered the receiver (storage tank). In the expansion valve, the liquid passes through a tiny opening so the pressure of the refrigerant is reduced. Because of the reduced pressure, the refrigerant begins to boil and partially turns to steam, forming a vapor-liquid mixture. It now passes into the cooling section (evaporator). The boiling point of the refrigerant is about 20°F lower than the surrounding air. As the liquid passes through the evaporator it begins to boil until it is completely vaporized before it leaves the evaporator. As the liquid passed through the evaporator, it needed heat to cause vaporization and it took the heat from the cooling water. When the refrigerant leaves the evaporator it is at a low pressure and warm - leaving the space cooled to the desired temperature. The heat gained by the refrigerant must be disposed of and the vapor returned to a liquid again before returning to the evaporator.

The compressor draws the vapor out of the evaporator and compresses it (raising the pressure) and circulates it to the condenser. Here the condenser removes the heat and changes it to a liquid again to start the cycle over again. The condenser cools the vapor by using an outside source of cooling water circulating through tubes inside the condenser. After the liquid leaves the condenser it falls to a receiver where the liquid is stored until needed.

That is the basic cycle for a compression refrigeration unit. Solar power can supply the electricity needed to operate the motor and thereby provide the cooling. Today most air conditioning and refrigeration units are the compression refrigeration type, but require substantial amounts of electricity to operate. Your home cooling unit, your refrigerator and freezer also use this type of refrigeration.

Another method of cooling is the use of steam jet refrigeration. This method is much simpler and requires no compression. The unit parts are basically a flash chamber and steam jets. The steam jets create a vacuum in the flash chamber. Water is sprayed into the low-pressure chamber and it partially flashes to vapor giving up some of its heat. The water that falls to the bottom is about 50°F and can be used for cooling.

Solar collectors are used to produce the steam for steam jet to draw a vacuum. As early as 1936 concentrating collectors were used for this type of refrigeration system.

The last type of system is the absorption refrigeration type. This unit is similar to the steam jet refrigeration system. The major difference is that a set of coils are placed within the flash chamber and the cooling water passes through these coils. Water is sprayed into the flash chamber and flashes to steam. The heat that is needed for the water to flash is given off by the cooling water. This water is then transported and used for cooling throughout the home or business establishment. Solar energy can be used again to produce the energy necessary for creating a vacuum, either by a vacuum pump or steam air ejector.

Two types of absorption units commonly used are the lithium bromide and ammonia water absorption units. The ammonia unit has proven to be the better, primarily because it can provide refrigeration at solar-collector temperatures.

Other methods of heating and cooling are being devised and studied. Systems that use heat pumps for both heating and cooling provide promise. There have been many other innovative ideas with respect to home heating and cooling. The near future holds prospects of abundant and economical methods for heating and cooling.

ACTIVITIES

1. Since solar energy is relatively free and we are posed with an energy crisis, attempt to answer the question: "Why don't we use solar energy more?" You may find that local power utilities officials may be able to help and there are numerous magazine and newspaper articles that deal with this problem (Activity IX-1).
2. Demonstrate an understanding of the relationship between solar and fossil fuel energy by writing an essay on "All Fuels are Solar Energy" (Activity IX-2).
3. Design a solar home that does not rely on standard forms of power (Activity IX-3).
4. Build a solar cooker (Activity IX-4).
5. Complete the "Solar Energy Puzzle" (Activity IX-5).
6. View "Some More Solar Solutions" (Activity IX-6).
7. Complete "A Puzzling Question" (Activity IX-7).
8. Make a bulletin board on "Our Energetic Mr. Sun" (Activity IX-8).
9. Define the vocabulary words (Activity IX-9).

Making A Solar Cooker

(Adapted from A Reflector Cooker, D.S. Halacy, Jr.)

(Activity IX-4)

1. Study the plans given.
2. Cut a base of cardboard 4 feet square.
3. Draw a circle with a 48 inch diameter on the base. Use a string and pencil.
4. Draw 2 lines perpendicular to each other through the center of the base. (Location of the main ribs)
5. Draw 2 main ribs as shown in plans (36 inch radius).
6. Cut out the 2 main ribs.
7. Lay out the 6 full ribs.
8. Carefully cut 6 full ribs in half.
9. Notch the 2 main ribs carefully as indicated in the diagram. The 2 main ribs will fit together.
10. Glue the 2 main ribs on the base as previously marked.
11. Glue 3 half ribs per quarter and align the ends with the outside circle already drawn.
12. Allow to dry.
13. Cut rim partitions and glue in place as shown in diagram.
14. Cut and try poster board to fit over the triangle-shaped frames. Allow about 1/8 inch overlap. DO NOT CEMENT YET.
15. Use the pattern to cut 15 more triangles (16 total).
16. Glue triangles on every other rib network (1/8 inch overlap). Press down until glue dries. You should have 8 openings (every other space open).
17. Glue the remaining 8 pieces in place. If the center doesn't meet or you have trouble with overlaping in the center, trim an inch or two from the center ends. The center can be covered with a separate piece of cardboard.
18. Seal all joints with masking tape.
19. Cut 16 pieces of smooth-surfaced aluminum foil slightly larger than the poster board pieces.

20. Rubber cement the foil to the poster board (shiny side up). Try to keep the foil smooth.

21. Install marker for focal point (curtain road) by cutting a short length of the larger diameter tube long enough to extend from the base to above the solar cooker surface.

22. Drill or punch a hole in the center of the reflector. You want a snug fit.

23. Cement the tube in place.

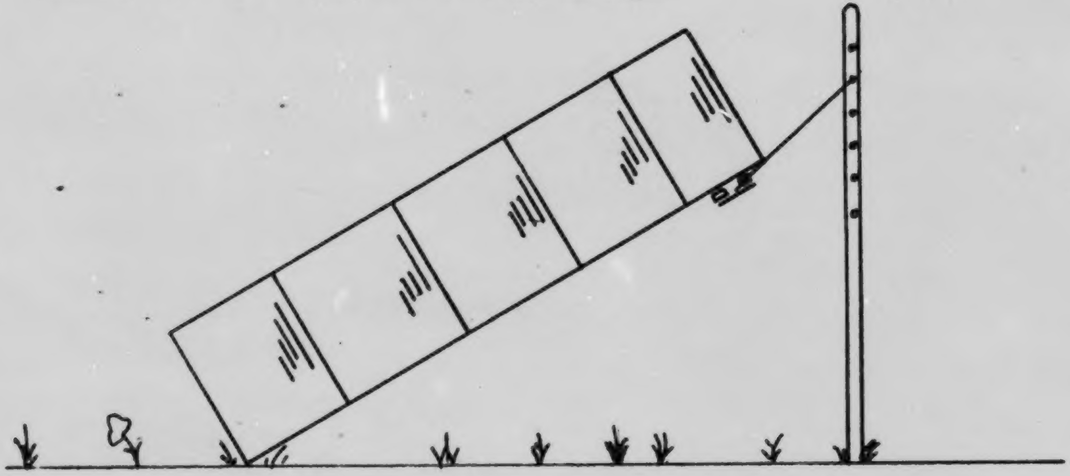
24. The other tube will slide in and out of the larger tube and is used to denote the focal point (1/2 of the radius) -- 18" from the surface of the reflector. As a double check, aim the reflector at the sun and adjust the tilt of the reflector until there is no shadow from the pointer. Hold a small piece of wrapping paper with a small hole in it right at the tip of the pointer. Move the paper and pointer until the smallest spot appears--this is the focal point.

25. Assemble the handgrill as shown from the diagram.

26. Cut 2 squares of cardboard 2" X 2" and 1 rectangle 4" X 2".

27. Glue the 2 squares on the back center of the reflector.

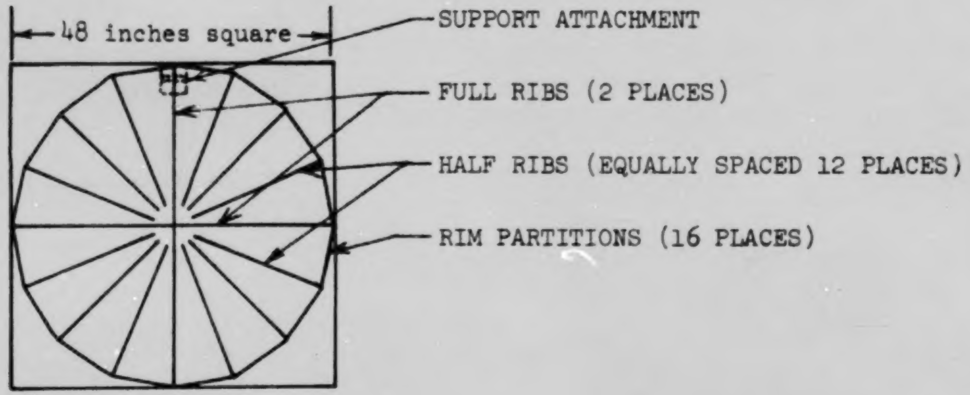
28. Glue the rectangular strip on top of the 2 squares. This leaves an opening for the clothesline to pass through.



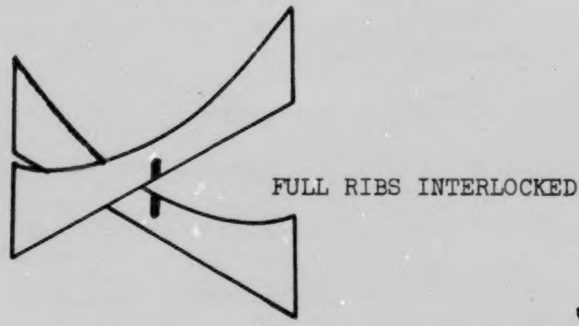
29. Run the clothesline through the openings in the slot made and tie.

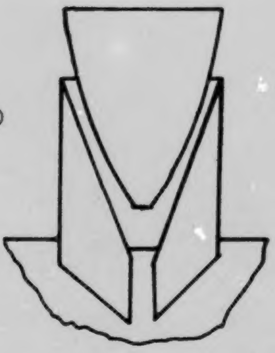
30. Drill holes in the broom stick 1 inch apart.

31. Drive the broomstick into the ground and the rope can be placed over the broomstick to position the reflector. Place a nail through a hole in the broomstick and rest the rope on the nail. The reflector can be adjusted as necessary by moving the nail.

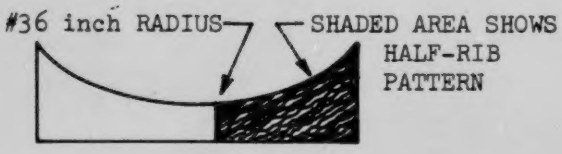

48 inches square
SUPPORT ATTACHMENT
FULL RIBS (2 PLACES)
HALF RIBS (EQUALLY SPACED 12 PLACES)
RIM PARTITIONS (16 PLACES)

BASEPLATE AND RIB LOCATION

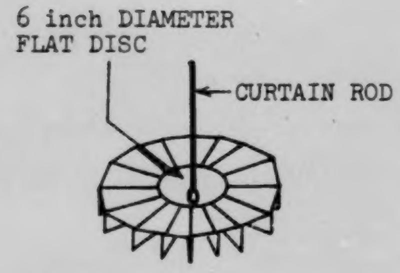

FULL RIBS INTERLOCKED



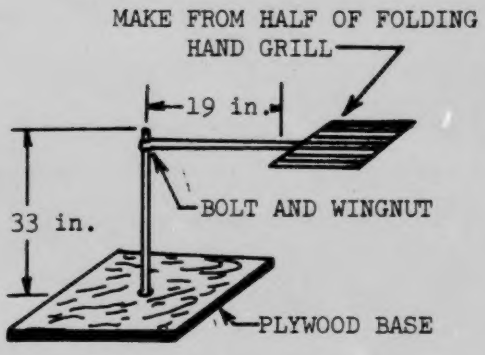
ASSEMBLY OF POSTERBOARD SECTIONS


#36 inch RADIUS
SHADED AREA SHOWS HALF-RIB PATTERN

RIB PATTERN


6 inch DIAMETER FLAT DISC
CURTAIN ROD

REMOVABLE POINTER ROD AND CENTER DISC INSTALLATION


MAKE FROM HALF OF FOLDING HAND GRILL
19 in.
33 in.
BOLT AND WINGNUT
PLYWOOD BASE

Solar Energy Puzzle

(Activity IX-5)

A list of words related to solar energy is given below the puzzle. Look for the words hidden in the puzzle. When you find one, circle it and mark it off the list until you have found all the words.

```
N O C I L I S J I T R U W O P E H M V A P E R O T C L L E C T R O
O T E H A M V A P O S I C O T I E N S I O N O T V T A L E A T R M
I S N S F U D C E R I W O T I Q A M Y U C V A I N P W M U Z O B R
T L A C E U L A T I Y O N F R I T E L P R Y E L O W P S G L E A I
A S O L R A H O E M P O L L U I ■ N O W S E R N I G M T U R E S G
R I E C I E M I S E M I W I X I O U D J S K W M C U Q I W O P C H
O P T I O L A A T I V I T Y L L F P A G K I N U L A T I O S L L E
P W O E R F U R A C E S I L I C ■ O H I D E N D W O D R S R G E Y
A V A P R M T E A P H M P U I L V S S I O N P H O V P R S I W I W
V L A T C O L L E P V A P L I O A S T A L F T E A P L C L L E C T
E N E R G Y ■ A ■ R A L O S ■ V P L ■ F U S I O N M H E L I O S ■
E U R O P C F P H A R I S F R U O C A N E L I V U E U S A L O N I
B L A E K M L O E N T U E S O F R L A T P L T A S E I R E S E A R
P U Z Z G I A L A G Q U E S T N I O H O M E D A ■ Y T R E A N Q S
M A T G N H T R T E A S U R C Y Z Z A T I O N E C V A V P O R I Z
E A T H M P ■ M ■ S I C I L E N A T P H O T O ■ I S N U V A P R S
F L A M P L P A P T E C O L L A T R ■ R G Y E R A G O Y M N U M S
V T I C O L L F U N A E C P L O I W R V R I Z A T S T I L I C O N
M P H L E T A S M S S M Z G O B O K A S T U S N L M C L D O Y D M
T R I D E A T K P I C K C S C M N A ■ F R I U S O O R S T R A F R
F U R N A C E G ■ R E W O P ■ D ■ I ■ S R O P A V I A T I F O R N
```

power

furnace

vapors

Ra

photo

voltaic

sun

fusion

Helois

Tonatiuh

heat of vaporization

collector

solar

heat pump

flat plate

energy

evaporation

silicon

306

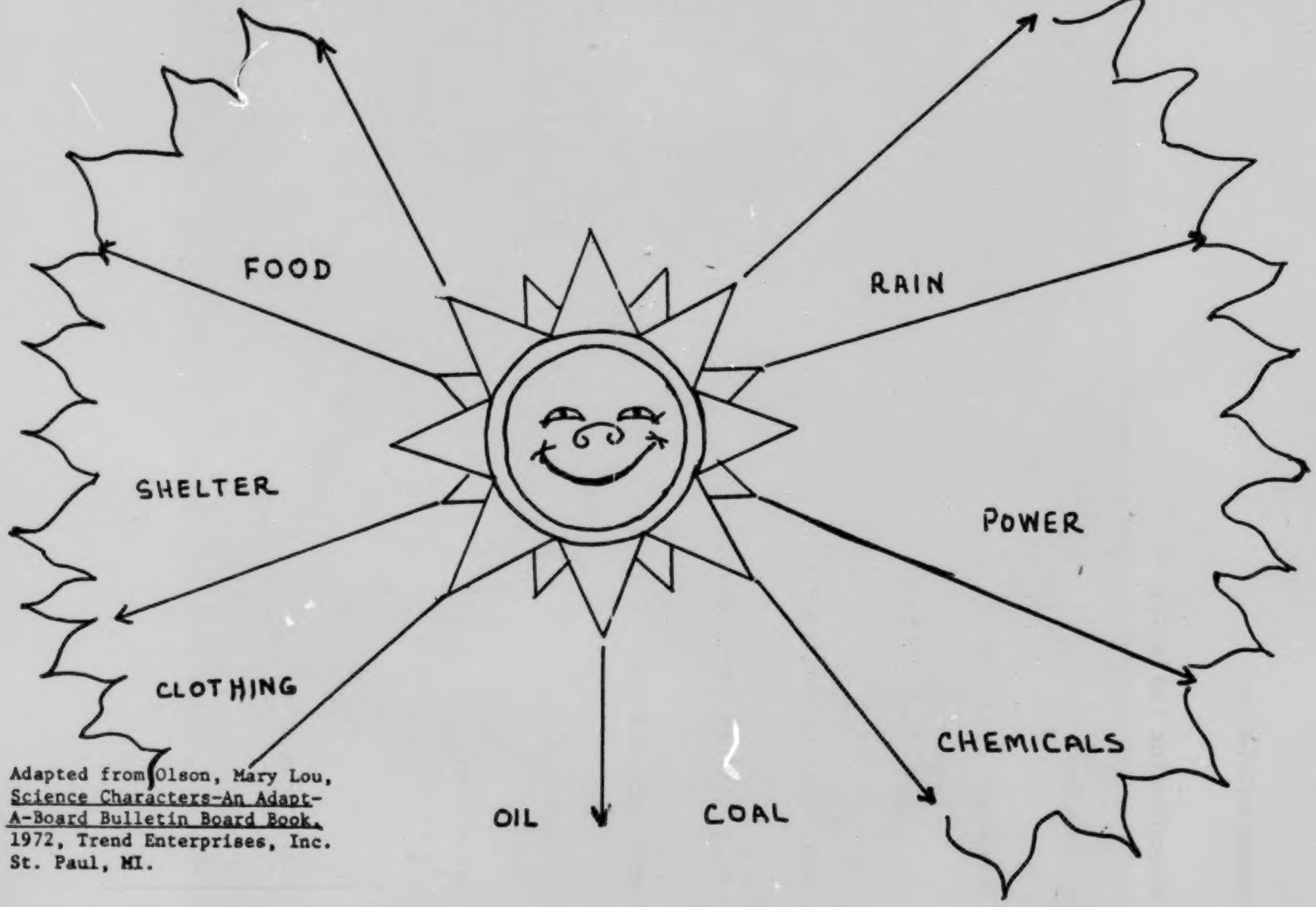
A Puzzling Question

(Activity IX-7)

You are hoping to have your own home some day. You may want to consider how you might heat or cool it if we have an energy crisis. Solar energy will be your most available resource. If you had solar collecting panels placed on your roof or in your yard, these might be some of the things you would have to consider: How much sunshine do we have yearly? What about cloudy, cold days and how would you store your solar energy collected? What kind of insulation would you use in your house? How would you get the energy transferred to where you could use it? What angle would you place your solar collectors? Are there any manufacturers of solar collectors for home use? How expensive are they if there are? And is there any concern for pollution where large numbers of solar collectors are grouped together?

Ask your teacher for help in answering these questions and also see what can be found in the libraries to help you. Try the Yellow Pages of the telephone book. Ask home builders and anyone else you might think of that could help you answer these questions.

OUR ENERGETIC MR. SUN


FOOD
RAIN
SHELTER
POWER
CLOTHING
CHEMICALS
OIL
COAL

Adapted from Olson, Mary Lou, Science Characters-An Adapt-A-Board Bulletin Board Book, 1972, Trend Enterprises, Inc. St. Paul, MI.

Vocabulary

(Activity IX-9)

1. cadium sulfide -
2. concentrating collector -
3. evaporation -
4. flat-plate collector -
5. heat pump -
6. latent heat of fusion -
7. latent heat of vaporization -
8. linear collector -
9. photoelectric -
10. photovoltaic -
11. silicon -
12. solar furnace -
13. vapor -

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide introductory material on solar energy. It covers the history of solar energy and various solar heating and cooling techniques. Students will need to read and discuss the information before attempting the activities.

Nine activities are included in this chapter. The first two are simply discussion questions which will stimulate thoughts about solar power. Designing a solar home (Activity IX-3) is a popular activity undertaken by architectural drafting classes and general science classes alike. The fourth activity is fairly simple and it is a great motivator if the class has a chance to cook a meal on the solar cooker. Activity IX-7 covers the various technical questions which must be asked if solar panels are actually installed, as they are certain to be in the future. The slide presentation, word puzzle, bulletin board and vocabulary list help foster comprehension of the solar energy concepts.

This chapter is an introduction of solar energy; much more intensive research and study can be done on this topic, or in related fields. School-aged children will be faced with more decisions concerning solar power as they reach adulthood.

List of Materials

Activity IX-1

paper and pen or pencil

Activity IX-2

paper and pen or pencil

Activity IX-3

paper, pencil, straight edge, resource material from library

Activity IX-4

cardboard (as required)

poster board (2 sheets)

aluminum foil (one roll)

plywood (one piece: 18" X 24")

3/4" aluminum tubing (approximately 64")

3/4" mounting flange (one)

grill (one)

curtain rod - one (2 tubes)

broomstick - four feet

clotheslines - one foot

glue (as required)

masking tape (as required)

3/16" by 1" bolt with wing nut (one set)

string and pencil

linoleum knife

razor knife (exacto)

pocket knife

nail

Activity IX-6

slides ("Some More Solar Solutions")

slide script

projector

Activity IX-7

pencil and paper

Activity IX-8

yarn

construction paper

glue

scissors

magic marker

thumb tacks

Activity IX-9

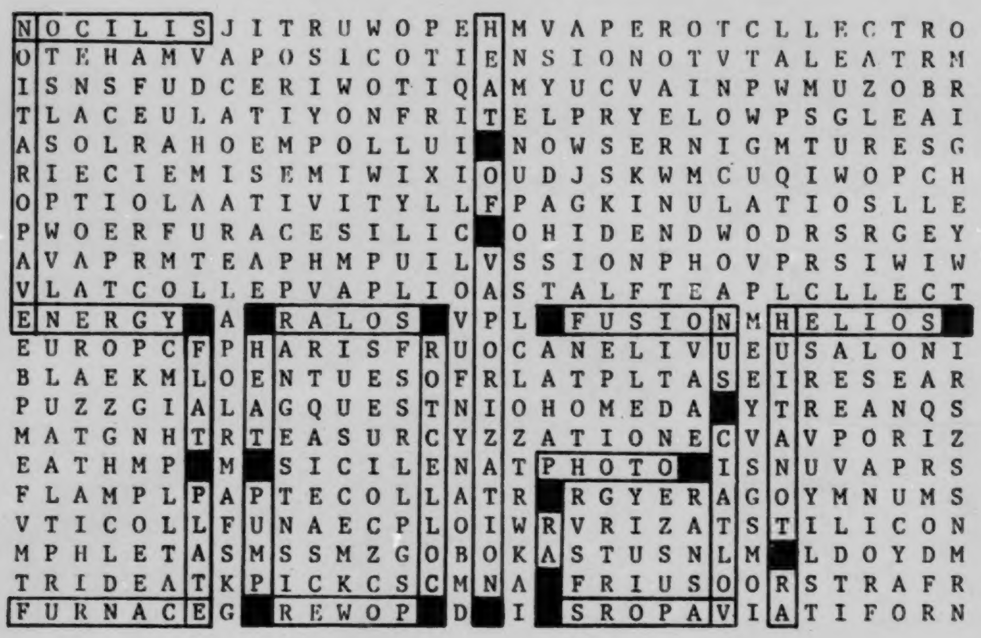
hand-out of vocabulary words (terms)

pencil and paper

Solar Engery Puzzle Answer

(Activity IX-5)

A list of words related to solar energy is given below the puzzle. Look for the words hidden in the puzzle. When you find one, circle it and mark it off the list until you have found all the words.



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N O C I L I S J I T R U W O P E H M V A P E R O T C L L E C T R O
O T E H A M V A P O S I C O T I E N S I O N O T V T A L E A T R M
I S N S F U D C E R I W O T I Q A M Y U C V A I N P W M U Z O B R
T L A C E U L A T I Y O N F R I T E L P R Y E L O W P S G L E A I
A S O L R A H O E M P O L L U I ■ N O W S E R N I G M T U R E S G
R I E C I E M I S E M I W I X I O U D J S K W M C U Q I W O P C H
O P T I O L A A T I V I T Y L L F P A G K I N U L A T I O S L L E
P W O E R F U R A C E S I L I C ■ O H I D E N D W O D R S R G E Y
A V A P R M T E A P H M P U I L V S S I O N P H O V P R S I W I W
V L A T C O L L E P V A P L I O A S T A L F T E A P L C L L E C T
E N E R G Y ■ A ■ R A L O S ■ V P L ■ F U S I O N M H E L I O S ■
E U R O P C F P H A R I S F R U O C A N E L I V U E U S A L O N I
B L A E K M L O E N T U E S O F R L A T P L T A S E I R E S E A R
P U Z Z G I A L A G Q U E S T N I O H O M E D A ■ Y T R E A N Q S
M A T G N H T R T E A S U R C Y Z Z A T I O N E C V A V P O R I Z
E A T H M P ■ M ■ S I C I L E N A T P H O T O ■ I S N U V A P R S
F L A M P L P A P T E C O L L A T R ■ R G Y E R A G O Y M N U M S
V T I C O L L F U N A E C P L O I W R V R I Z A T S T I L I C O N
M P H L E T A S M S S M Z G O B O K A S T U S N L M ■ L D O Y D M
T R I D E A T K P I C K C S C M N A ■ F R I U S O O R S T R A F R
F U R N A C E G ■ R E W O P ■ D ■ I ■ S R O P A V I A T I F O R N
```

power

furnace

vapors

Ra

photo

voltaic

sun

fusion

Helois

Tonatiuh

heat of vaporization

collector

solar

heat pump

flat plate

energy

evaporation

silicon

TEST

1. The Greeks worshiped their sun god __________.

* A. Helios

B. Ra

C. Phaethon

D. Baal

2. The process by which a plant uses the sun to combine water and carbon dioxide in plant growth is _________.

A. hydrolysis

* B. photosynthesis

C. pyrolysis

D. osmosis

3. The sun's energy stored in dead plants and animals after thousands of years can be recovered as __________.

A. geothermal geysers

B. uranium

C. petrified wood

* D. fossil fuels

4. In 212 B.C. a fable tells of the burning of the Roman fleet using solar energy. Who was the great man who harnessed the solar energy?

A. Soccrates

B. Homer

* C. Archimedes

D. Pathayoris

5. During the Renaissance, Solomon de Caus, a Frenchman, built a pump powered by a _______ ________.

* A. solar engine

B. solar cell

C. solar furnace

D. solar battery

6. During the 18th century Lavoisier created temperatures of greater than 3000°F with his ____________.

A. solar engine

B. solar cell

* C. solar furnace

D. solar battery

7. The 18th century used concentrating collectors, but the 19th century shifted to the use of ___________.

A. linear collectors

* B. flat-plate collectors

C. circular collectors

D. convex collectors

8. Experimentation with solar energy dwindled during the late 19th and early 20th century because ____________________________________

A. it showed no promise.

B. it couldn't be used for electricity.

C. they hadn't found a way to use the flat-plate collectors.

* D. fossil fuels were abundant and cheap.

9. American indians that used dwellings similar to the sodhut on the Kansas plains, made of adobe and stone were the _________.

A. Aztecs

B. Karaukaws

C. Navajos

* D. Pueblo

10. Home water heating with solar energy became widespread early during the ____________.

A. 20's

* B. 30's - 40's

C. 50's - 60's

D. 70's

11. Cadium sulfide is one type of photovoltaic cell. Another is ________.

A. plutonium

B. aluminum

C. tungsten

* D. silicon

12. When water at 212°F changes to steam at 212°F it takes

A. 180 BTU's

* B. 977 BTU's

C. 144 BTU's

D. 212 BTU's

13. For one pound of water to change in temperature one degree it takes __________.

A. 1 calorie

B. 144 BTU's

C. 977 calories

* D. 1 BTU

14. An air-cooled flat-plate collector's major disadvantage is ________.

* A. large ducts are required.

B. it cools off quickly.

C. cost more money to install than water.

D. its heat cannot be regulated easily.

15. A good rule of thumb for the most effective installation angle of a solar collector is the

A. latitude + 5°

B. longitude + 10°

* C. latitude + 10°

D. longitude + 5°

Some More Solar Solutions

(Slide Presentation: Activity IX-6)

Slide	Narration
1. Some More Solar Solutions	
2. Solar Collector of 1878	This solar collector was invented to power a steam engine and was placed on exhibition in Paris, France in 1878.
3. Greenhouse	Greenhouses, like this on the Texas A&M University campus, have been designed to take advantage of solar energy to grow plants for many years.
4. Solar Panel	One way to trap solar energy is to place a flat plate of some kind to catch the rays of the sun that fall on it to heat water or air that can be used to cool or heat a building. The panel seen here is used for solar heating. It is usually a shallow, rectangular box covered by glass or clear plastic.
5. Solar Panel	Under the panes is a surface that is usually black to absorb the sunlight without too much reflection. If water is to be heated, air or water may be transferred below the heating surface to collect the energy being radiated. There must be insulation on the sides and back of the panel and the panels must be attached to one another so that the water or air can move from one panel to another.
6. Solar Panel	The size of the panel needed and the number needed for a home or industry will depend on where the building is located geographically. On an average, it has been calculated that a panel that covers about half the square footage of the home will help to provide 40 to 60 percent of the annual heating requirements. A large storage tank would be needed to store hot water for one to three days if there wasn't enough sunshine.

7. Solar Voltaic Cells	This solar energy panel made of voltaic cells could be used to supply electrical power for direct use or for charging batteries. It can provide power for air conditioning and heating and can generate electricity for anything that uses it. Unfortunately, these panels are not very efficient because they must be cooled, and the direct current they produce must be changed to alternating current.
8. Parabolic mirror	This large parabolic mirror focuses light from smaller mirrors onto a solar furnace located in front of it. It is possible for the solar radiation to raise the temperature of the furnace to more than 6,000°F. This could convert water to steam which could then generate electricity.
9. Satellite solar power station	Solar collectors may someday orbit in space and beam the energy they collect to earth by means of microwaves. Many ideas for future devices to harness solar energy have been given serious consideration. The children of the future may see solar energy collected and used in such great amounts that it will exceed all possible dreams.
10. The sky	As we have learned, energy from solar radiation may last as long as our universe does, but we need more technology on how to capture and transform it for our use.

What part will you play in the energy game of the future? Will you help to conserve the decreasing natural energy resources we have today and also work to help develop new resources for the future? How, when, and where do we begin?

RESOURCE LIST

Books

Clegg, Peter. *New Low-Cost Sources of Energy for the Home*, 1975, Garden Way Publishing, Charlotte, Vermont 05445.

Olson, Mary Lou, *Science Characters - An Adapt-A-Board Bulletin Board Book*, 1972, Trend Enterprises, Inc., St. Paul, Minnesota.

Our Wonderful World, Vols. 10 and 11, 1968, New York: Grolier, Inc.

Solar Dwelling Design Concepts. The AIA Research Corporation, Washington, D.C., May 1976.

Magazines

"Concentrating Collectors for Solar Heating and Cooling", C. P. Gilmore, *Popular Science*, October 1976, pp. 96-98.

"Heat Pumps Cheapest Cooling and Heating for your Home?", Ronald Derven, *Popular Science*, September 1976, pp. 92-95.

"Low Technology Solar Homes that Work with Nature", Travis Price, *Popular Science*, December 1976, pp. 96-98.

"Solar Energy for Heating and Cooling", ERDA, Office of Public Affairs, Washington, D.C. 20545.

Solar Energy Research, Development and Demonstration Act of 1974.

"Solar Energy", *Shell Reports*, January 1976.

"Solar Energy Utilization for Heating and Cooling", John I. Yellott, U.S. Government Printing Office, Washington, D.C.

"Solar Window", Edward Moran, *Popular Science*, March 1977, pp. 24-26.

"Sun Power for Space Heating", Edward Moran, *Popular Science*, January 1977, pp. 60-62.

"Trickle-down Collectors: How Efficient?", Richard Stepler, *Popular Science*, January 1977, pp. 76-77.

"Waste-Treatment Plant Uses On-Site Energy" Elaine Smay, *Popular Science*, September 1976, p. 97.

Films

The following films are obtainable from Energy Research and Development Administration (ERDA), ERDA Film Library, Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

#0452 Your Place in the Nuclear Age (1969), 26 minutes, color

#0474 To Imitate the Sun (1971), 33 minutes, color

#0488 To Bottle the Sun, 5 1/2 minutes, color

#0499 Here Comes the Sun (1974), 15 minutes, color

#0502 Putting the Sun to Work (1974), 5 minutes, color

Pamphlets

American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia, 22209, "Consumer's Guide to Energy Conservation with Natural Gas."

Central Power and Light Company, P. O. Box 2121, Corpus Christi, Texas 78403, "The Story of Electricity," Mini-unit on electricity. Copies may be obtained by writing to Joe Valadez, Director of Youth Programs.

Consumers Power Company, Jackson, MI., "The Energy Problem and You."

Edison (Thomas A.) Foundation, Southfield, Michigan, "Energy Conservation Experiments You Can Do."

Edison Electric Institute, New York, "Energy Savings Begin At Home."

Electrical Industries Association, Los Angeles, California, "The Energy Savings Guide Book."

Federal Energy Administration, Washington, D.C. 20461, "Tips for Energy Savers."

Federal Power Commission, Washington, D.C., "Measures for Reducing Energy Consumption for Homeowners and Renters."

Houston Lighting and Power Marketing Research Department, Houston, Texas "Dollar Wise Use of Electricity."

Illinois, Champaign, (University of Illinois) Small Homes Council, "Living with the Energy Crisis."

Lone Star Gas Company, 301 South Harwood Street, Dallas, Texas 75201, "Energy Conservation in the Home."

Metropolitan Life Insurance Company, New York, "Exploring Your Environmental Choices as a Family."

Mobil, "Alternate Energy Sources," Toward a National Energy Policy, Mobil Oil Corporation, 150 E. 42nd Street, New York 10017.

Pacific Gas and Electric Company, San Francisco, California, "The Meter Minders Guidebook."

Potomac Electric Power Company, "All-Year Energy Savings All Around the House."

Shell Oil Company, Houston, Texas, "Shell Reports - Solar Energy."

U.S. Energy Research and Development Administration, Washington, D.C. 20545, "Solar Reprints from ERDA."

ENCORE

Chapter 10

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. describe how electricity is produced from nuclear energy.
2. describe the fission process.
3. form an opinion about nuclear power plant safety.
4. compare nuclear energy to coal, oil and natural gas.

NUCLEAR ENERGY

The basic concept of electrical energy production is that steam is used to drive a turbine generator that produces electricity. A nuclear power plant is no different than any other power plant in the basic concept. Heat energy of the steam is changed to mechanical energy in the turbine, and the generator converts mechanical energy into electrical energy. The only difference in the nuclear power plant and a conventional power plant is the origin of the heat to produce steam.

Conventional plants produce steam by burning coal, oil or gas to heat water. The process of burning the coal, oil or gas gives off heat through combustion. In nuclear power plants there is no burning or combustion. Heat is produced by fission and transferred to the water to produce steam.

What is the fission process? The process requires a particular element with a large nucleus, uranium or plutonium. Most reactors use uranium. Natural uranium is found in three isotopes. That means that they are all alike chemically, but each has a different size nucleus. For example, uranium 235 (U235) has a combination of neutrons and protons totaling 235. U is another uranium isotope. Its nucleus contains a combined total of 233 neutrons and protons. Uranium 238 (U238) has 238 combined neutrons and protons to make up the nucleus. These are the three most commonly found isotopes of uranium occuring in nature. The uranium 235 is the most commonly used uranium isotope because it can split (fission) when struck by a free neutron (a subatomic particle usually found in the nucleus of an atom). When the neutron strikes the nucleus of an atom such as uranium, it splits into two pieces that fly apart rapidly and collide with their environment. When they collide they give off their energy (kinetic) in the form of heat.

When the nucleus splits, not only fission fragments are released, but free neutrons are also given off. If these free neutrons collide with another U235 atom they can cause a chain reaction of U235 atoms being split (see Figure X-1). This chain reaction is how we get heat from a nuclear power plant. It takes more than 30 billion fissions per second to produce one watt of electrical energy.

Types of Nuclear Reactor Plants

Boiling Water Reactor

Now that you know where the heat comes from, how do we get it to boil water? There are numerous heat transportation modes called coolants. In a Boiling Water Reactor (BWR) the heat is generated in a group of fuel cells containing U235 called the reactor. Water (coolant) enters the reactor and passes between the fuel cells and absorbs the heat generated within the cells. The water is heated to the boiling point and steam is formed in the upper portion of the reactor. From here the steam travels to a turbine-generator to produce electricity (see Figure X-2).

Pressurized Water Reactor

The Pressurized Water Reactor (PWR) is very much similar to the Boiling Water Reactor. The difference is the PWR uses two separate systems to produce the steam. Again, water passes through the reactor and absorbs the heat, but the system is under enough pressure that the water does not boil. The water then flows to a steam generator. In the steam generator, the hot reactor water passes through tubes that are submerged in non-reactor water. The non-reactor water is then returned to the steam generator and the cycle begins again. The reactor water is pumped to the reactor to be heated again and this cycle is started again (see Figure X-3).

FISSION PROCESS

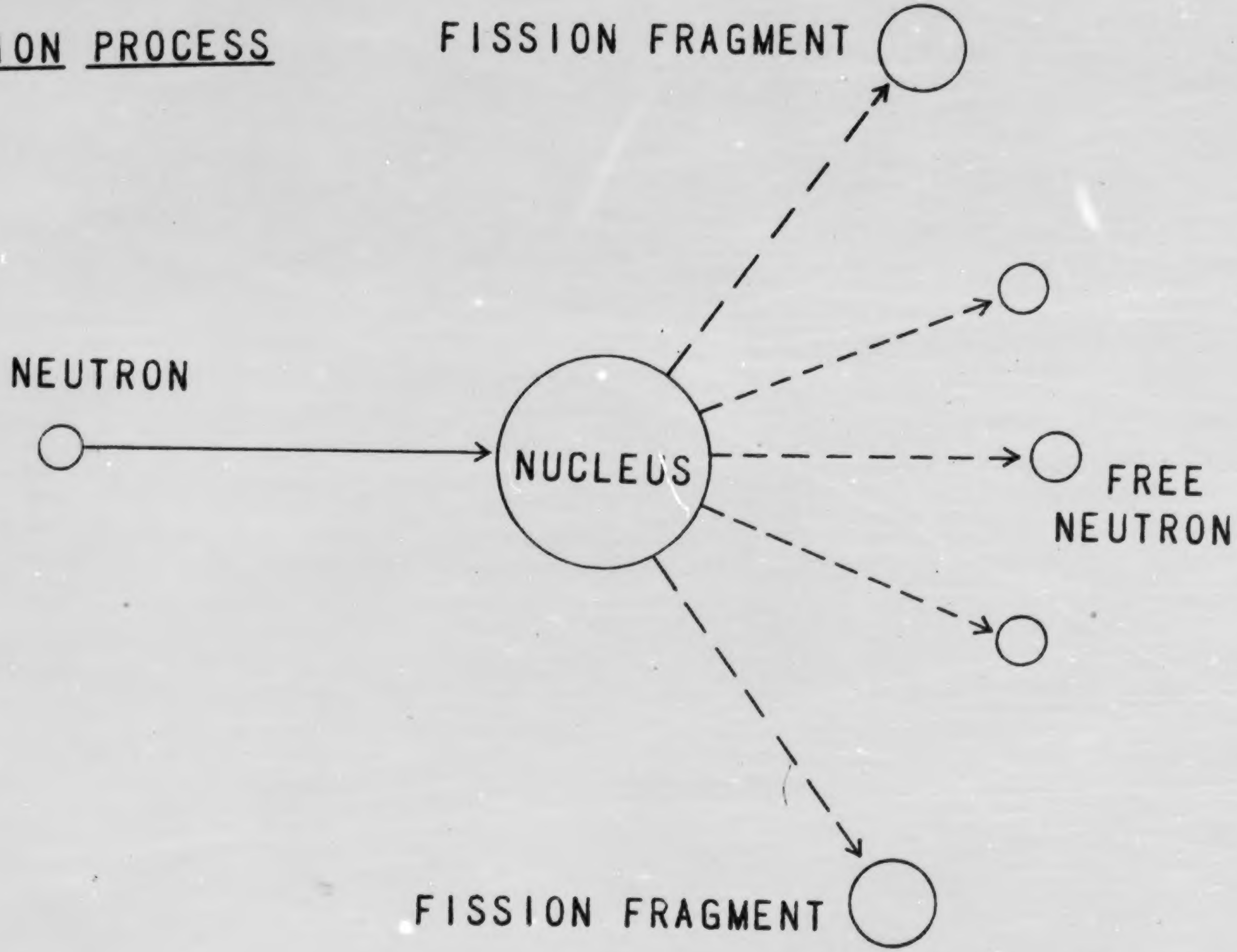

FISSION FRAGMENT
NEUTRON
NUCLEUS
FREE NEUTRON
FISSION FRAGMENT

Figure X - 1

BOILING WATER REACTOR

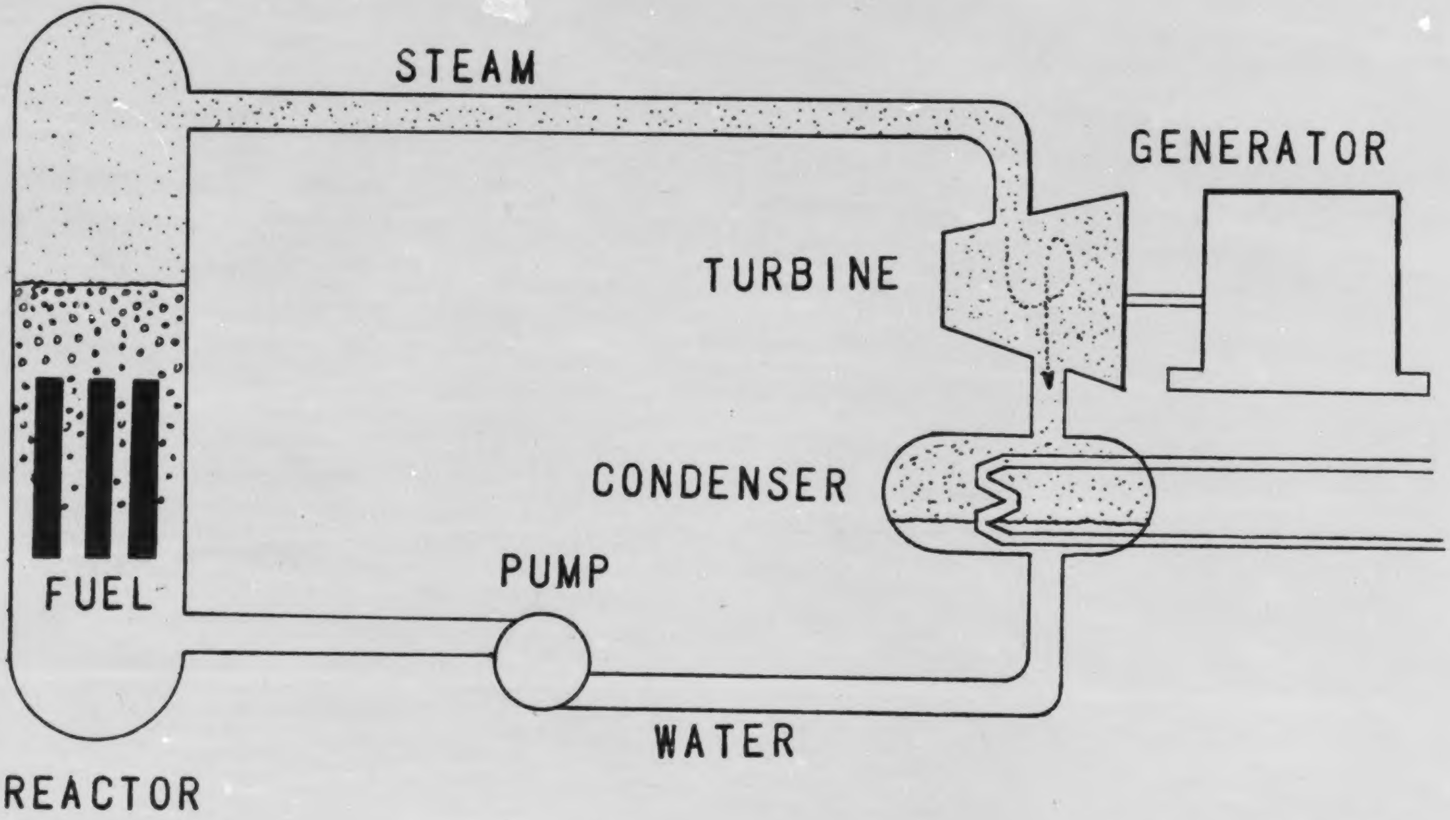

STEAM
GENERATOR
TURBINE
CONDENSER
PUMP
FUEL
WATER
REACTOR

Figure X - 2

PRESSURIZED WATER REACTOR

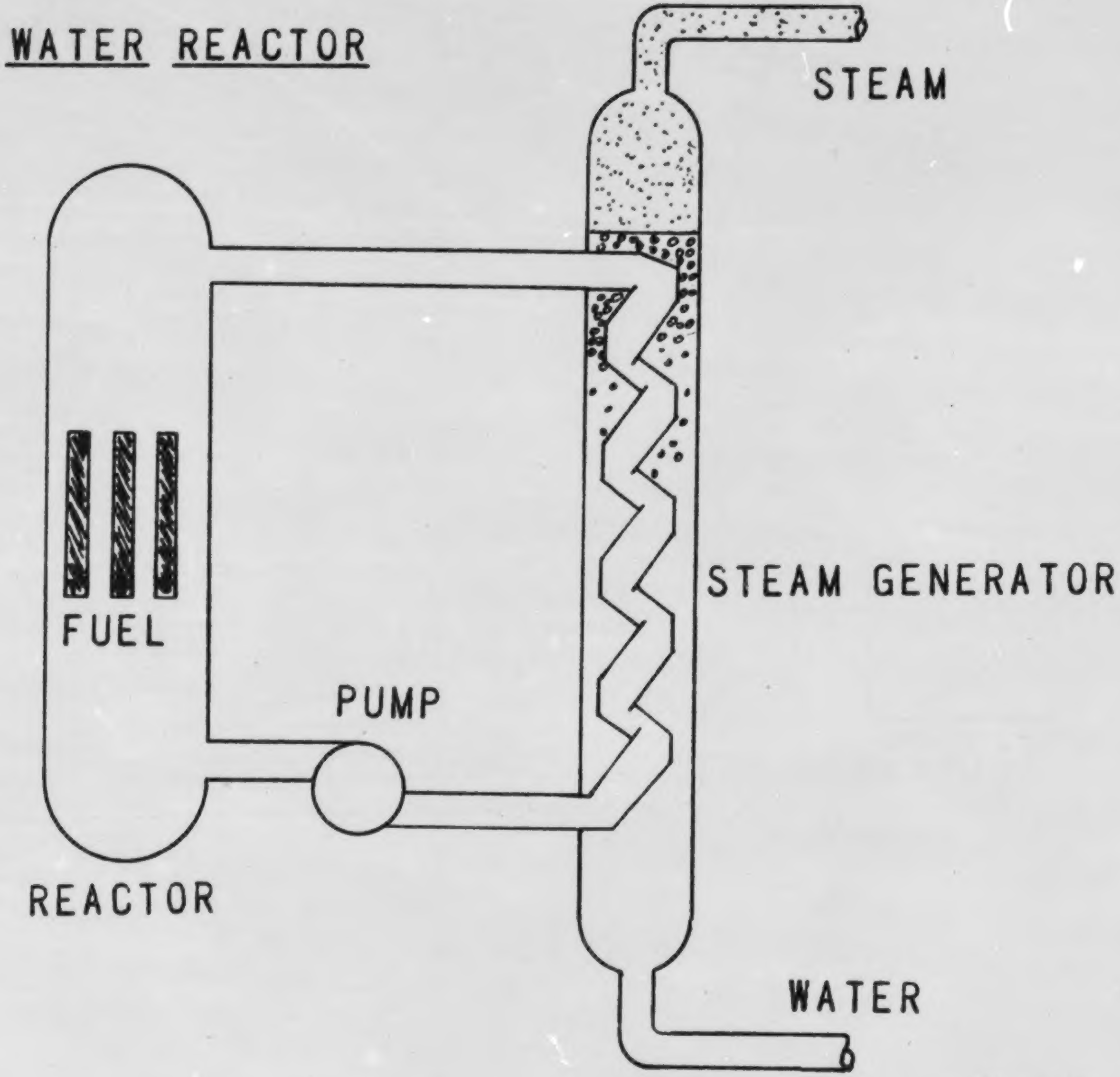

STEAM
FUEL
PUMP
STEAM GENERATOR
REACTOR
WATER

Figure X - 3

The water in each system never mixes, but heat is transferred from the reactor to the steam system.

Gas-Cooled Reactor

Gas-cooled reactors are similar to the PWR. The big difference is that helium or carbon dioxide is used instead of water to remove the heat from the reactor. The gas cannot be pumped; therefore, blowers are used to circulate the gas. The energy required to drive the blowers for a 80,000 KW plant would be equivalent to operating 400,000 twenty-inch window fans. The gas-cooled reactor differs from the PWR in other respects, also. The PWR uses water to transfer the heat, but it is also used as a "moderator". The moderator is a substance used to slow the neutrons and increase the probability of causing fissions. The gas-cooled reactor has to have a moderator added. The gas is not a moderator. Graphite is used as a moderator because it can withstand high temperatures as well as slow down neutrons. One cubic foot of water will remove more heat than one cubic foot of gas. Therefore, a major disadvantage of a GCR is that it has to be larger than a PWR (see Figure X-4).

Heavy Water Reactor

Heavy water reactors use deuterium (sometimes called heavy water)--an isotope of hydrogen--as a moderator.

Remember that the coolant is the mode of transportation for heat from the reactor to the steam generator. In the gas-cooled reactor, of course, gas was used, and in the PWR water was used. In the Heavy-Water Reactors (HWR) a variety of coolants may be used such as: organic compounds, gas, water or heavy water. The reason these different mediums can be used is because the moderator is outside the system. The heavy

GAS COOLED REACTOR

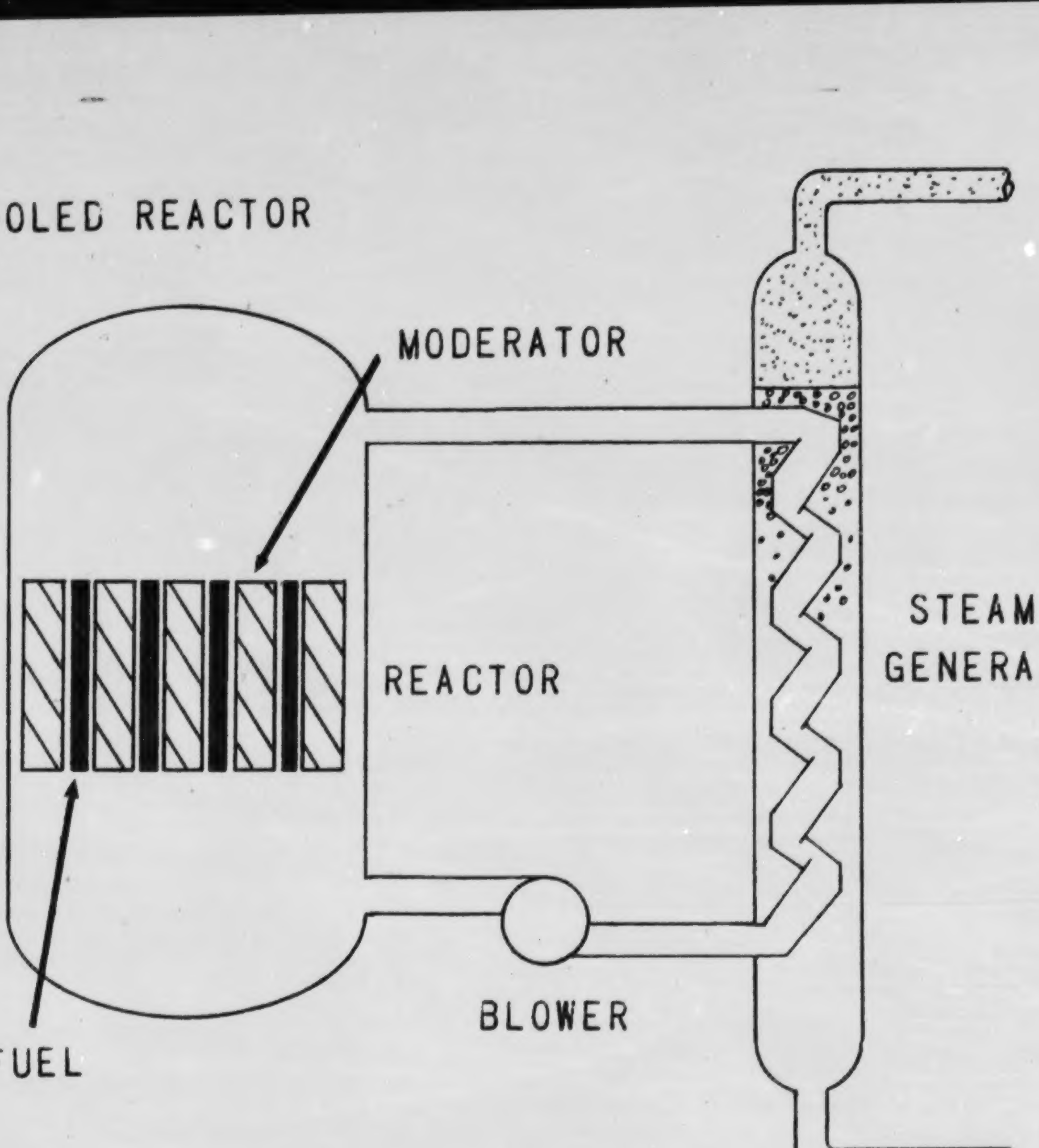

MODERATOR
REACTOR
STEAM
GENERATOR
FUEL
BLOWER

Figure X - 4

HEAVY WATER REACTOR

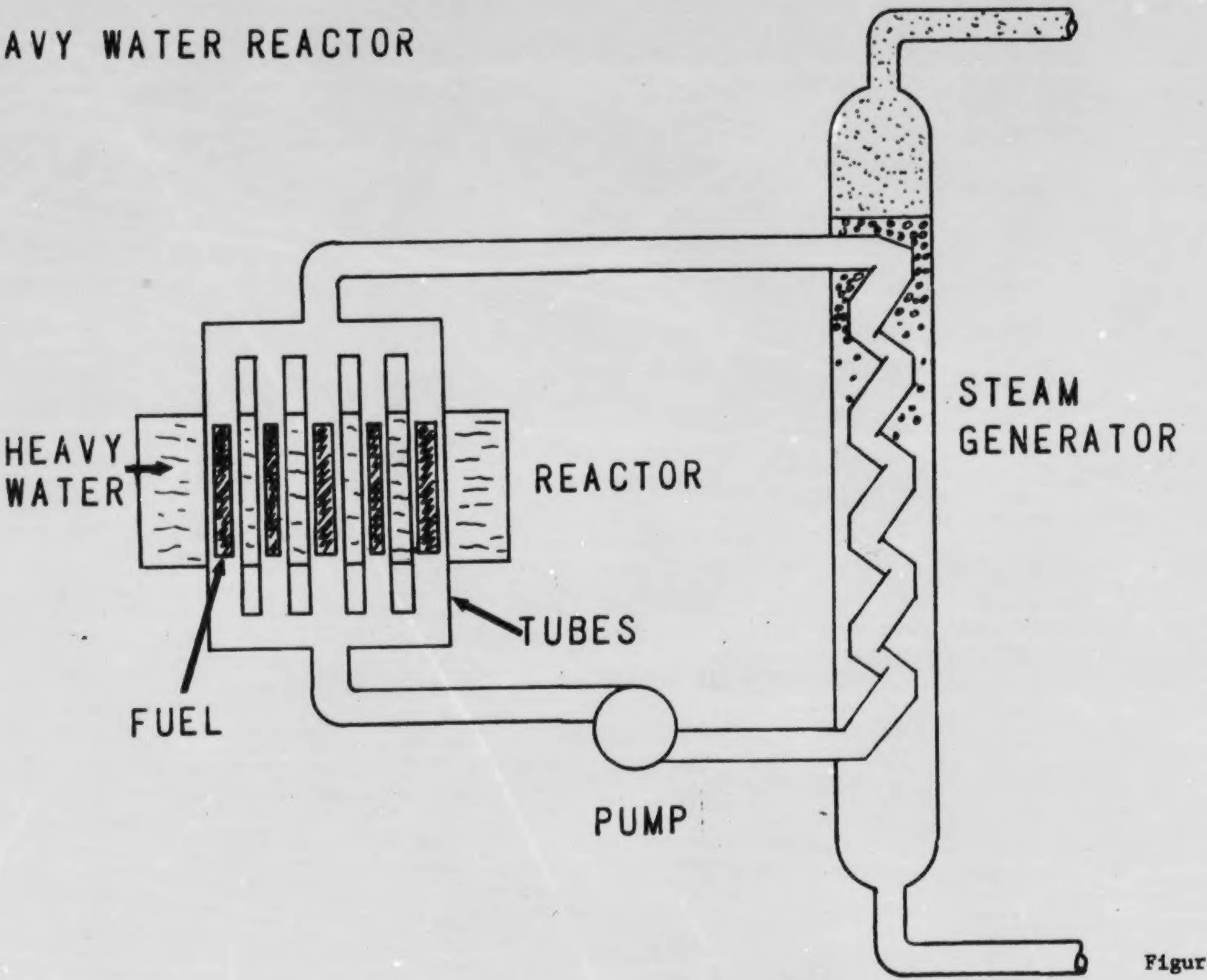

HEAVY WATER
REACTOR
FUEL
TUBES
PUMP
STEAM GENERATOR

Figure X - 5

water used as a moderator is held in a tank. The tank surrounds a number of tubes that contain fuel. The coolant can flow around the fuel and remove the heat and never come in contact with the moderator (see Figure X-5).

One of the major advantages of the HWR is its fuel consumption is low and it can use U238--natural uranium. Therefore, it is less expensive than other reactors that use enriched U235. Another advantage of the HWR is hotter steam can be produced because of the use of moderators other than water.

Breeder Reactor (Liquid-Metal-Cooled Breeder)

The Breeder Reactor is somewhat more complex than the other reactors discussed. The basic operation of a Breeder Reactor hinges on the use of U238 as a fuel. Uranium 238 occurs in nature with U235, but the U238 does not fission as readily as the U235. When U238 absorbs a neutron, the fission is converted to plutonium (Pu239).

If you recall the discussion on fission, free neutrons are released with each fission. All of these neutrons do not cause other fissions. Some of them are absorbed in the reactor walls, shielding or water. Therefore, careful selection and arrangement of materials are made so that the neutrons not needed for the fission chain reaction be absorbed by the U238 or Thorium 232 to produce fissionable materials such as Pu289 and U233. To produce the U233 which is also an accepted fuel, thorium 232 is used. When the Pu239 or U233 (fissionable materials) are produced in a greater quantity than are used, the process is considered as a breeding process.

At the present time only one breeder reactor has been successfully operated--the liquid-metal-cooled breeder (see Figure X-6).

LIQUID METAL COOLED

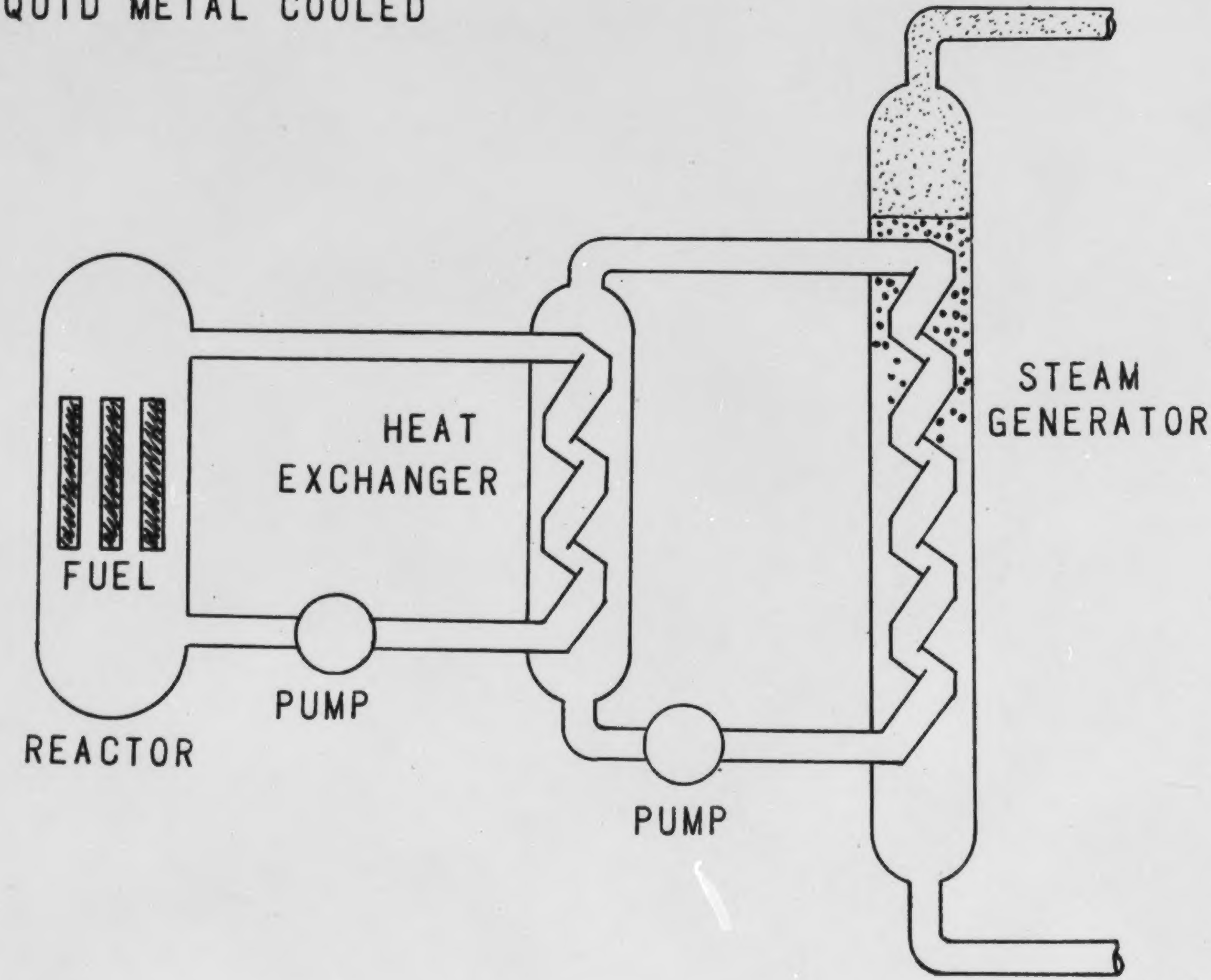

FUEL
REACTOR
PUMP
HEAT
EXCHANGER
PUMP
STEAM
GENERATOR

Figure X - 6

The basic concept of operation is the same as we have discussed before. The steam-generating system is the same. The only real difference is the use of a heat exchange to remove the heat from the reactor system and transport the heat to the steam generator. As the title suggests, the coolant is the liquid metal such as sodium or lithium, normally sodium. If you can visualize a liquid metal, mercury is a liquid metal. The liquid metal is used in both the reactor system and the heavy water system because of its outstanding heat transfer properties and its nuclear characteristics.

The liquid metal reaches a temperature of 1000°F before reaching the heavy water system and there transfers its heat to the heavy water system. The metals in the heavy water system carries the heat to the steam generator where 900°F steam can be produced. Steam at higher temperatures are desirable for turbine operation. If the steam can have all the moisture removed before reaching the turbine, the operation of the turbine is much more effective.

The liquid metal has some advantages as well as disadvantages. The advantages: its heat removal capabilities are high; therefore, the size can be reduced for the same output as compared to a PWR or BWR. Unlike water the metal does not flash to a vapor at 212°F; therefore, high pressures are not needed to reach higher temperatures. This, then, reduces the chances of radioactive materials being released to the environment due to a leak.

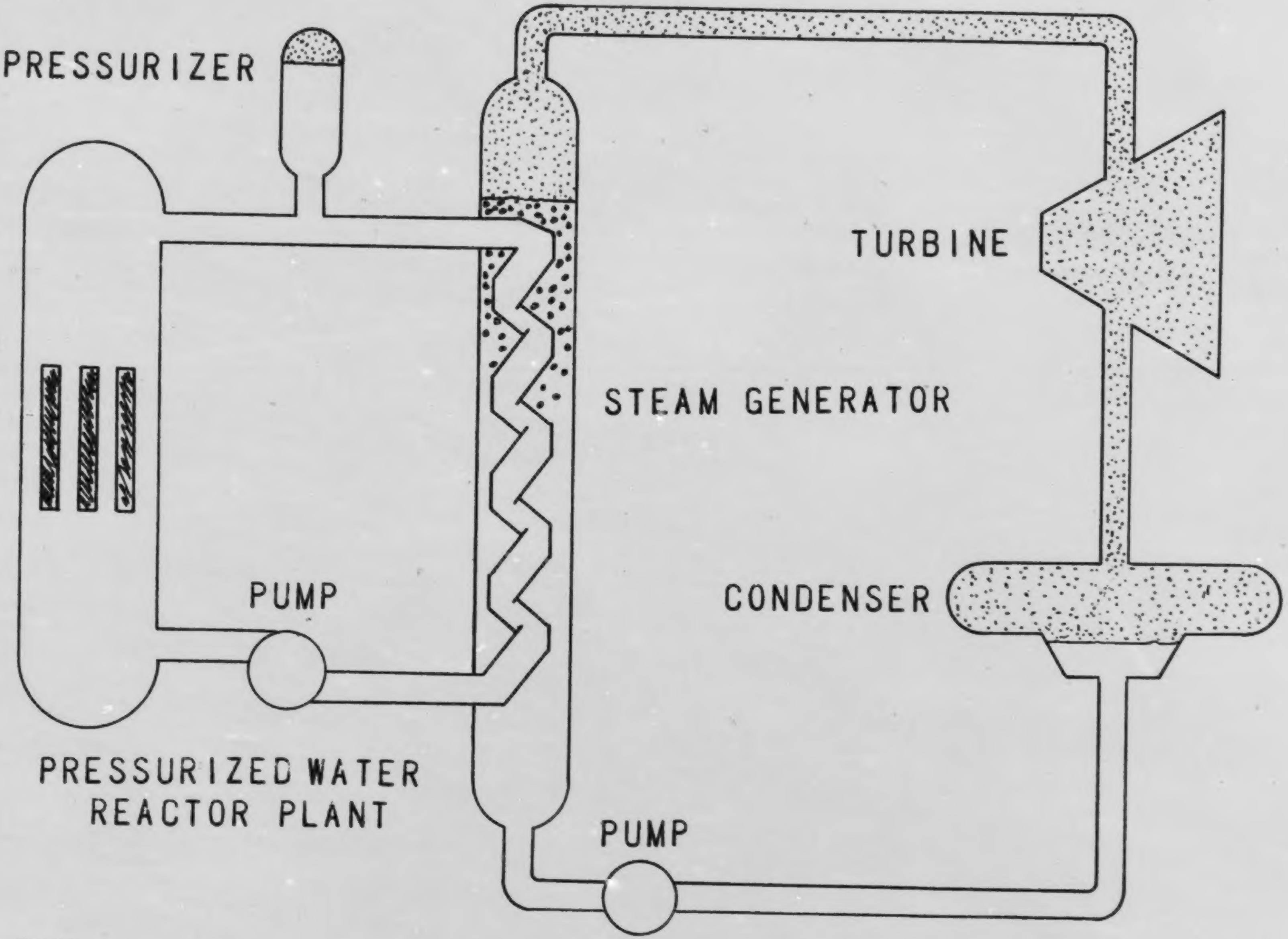
An undesirable feature of liquid metal is that it chemically reacts with water or steam. That is the reason for designing the liquid metal cooled reactor plant with a heat exchange between the reactor and steam plant. This allows for isolation of the reactor system for any such violent chemical reaction.

Parts of a Reactor

Let's take a closer look at a basic nuclear power plant, its components, characteristics and functions of the various components. The Pressurized Water Reactor (PWR) is the most common type used today. (See figure 7) The primary loop components are the reactor pressure vessel, the pressurizer, the steam generator and the primary coolant pump. The reactor pressure vessel is basically the housing for the reactor core. The reactor core contains the fuel. The vessel also houses equipment necessary for proper operation and protection of the reactor core. The pressure vessel is designed to withstand operating pressures of 2250 pounds per square inch and temperatures of 550°F to 600°F. The vessel weighs about 1 million pounds empty and 1.5 million when full of water. The vessel is approximately 40 feet high and 16 feet in diameter with walls about a foot thick. The pressure vessel has a removable head for removal of spent fuel and replacement of a new core.

The reactor core is the heart of the reactor plant. The core is comprised of fuel in the form of UO_2 (uranium oxide). The UO_2 is sealed in ½ inch tube, 12 feet long, made of zircaloy. There are approximately 200 tubes arranged in a square pattern to form a fuel assembly. The tubes are arranged so they do not touch, to permit cooling water to flow between them. Each fuel assembly is about 8 inches square by 12 feet long and weighs 1300 pounds. This fuel assembly is combined in a geometric configuration with about 200 more to form the reactor core. The total dimension of the core may be 12 feet by 12 feet for an 800,000 Kw (.8 megawatt reactor).

Remember when we talked about fission that we needed a chain reaction to give us the heat necessary to produce the steam. Within the core the chain reaction is controlled by use of control rods. The control rods


PRESSURIZER
TURBINE
STEAM GENERATOR
PUMP
CONDENSER
PUMP

PRESSURIZED WATER
REACTOR PLANT

PRESSURIZED WATER REACTOR PLANT COMPONENTS

1. Reactor
2. Pressurizer
3. Pump
4. Steam Generator
5. Pump
6. Turbine
7. Condenser
8. Fuel

are usually made of a material that can absorb a neutron that might cause fission. Therefore, control rods are placed in between a given number of fuel assemblies to absorb neutrons and limit the chain reactions (see Figure X-8).

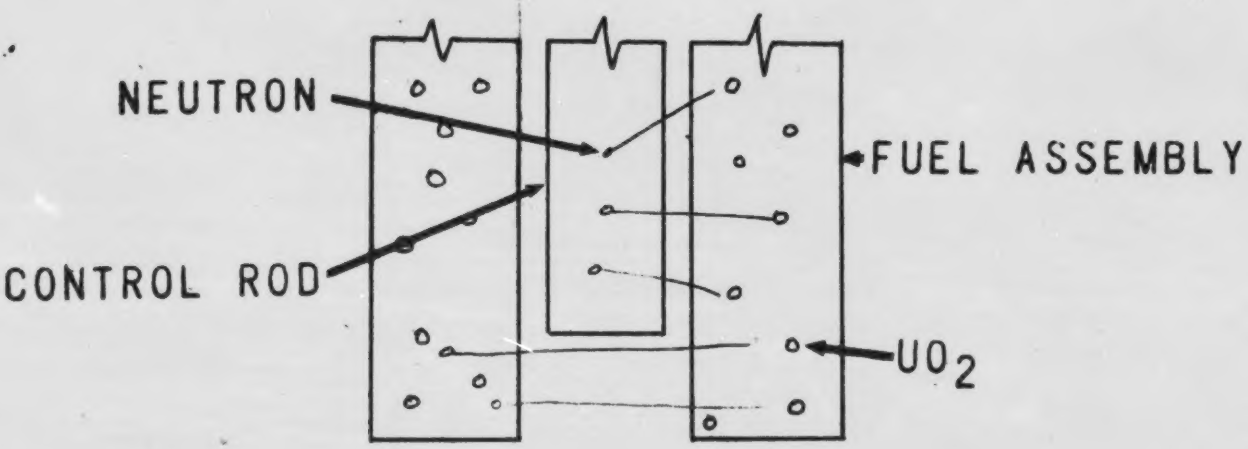

NEUTRON
FUEL ASSEMBLY
CONTROL ROD
UO_2

Figure X-8

Let's assume the control rod is on the bottom (see Figure X-9).

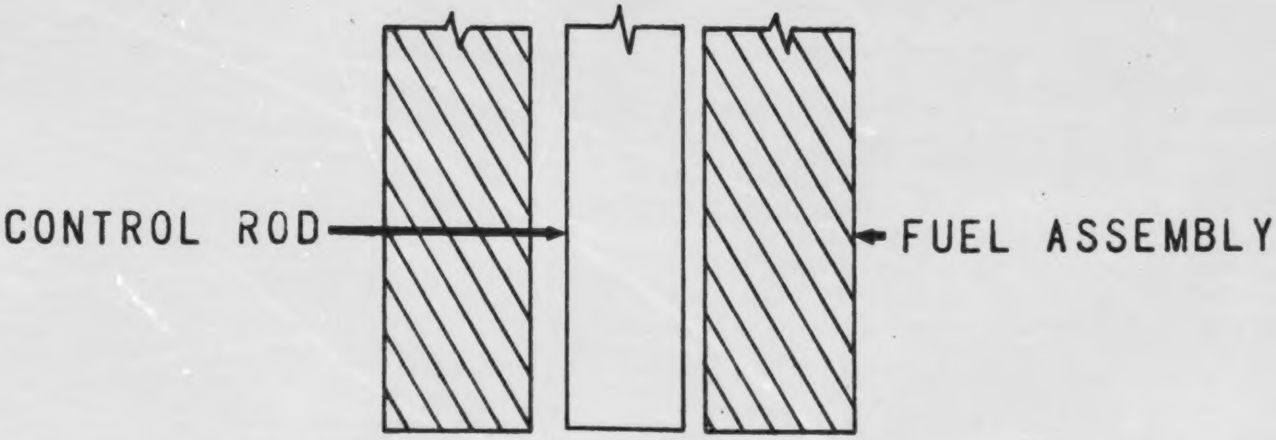

CONTROL ROD
FUEL ASSEMBLY

Figure X-9

The UO_2 fissions naturally and therefore emits neutrons that could cause a chain reaction if they were to strike another UO_2 pellet. With the control rod inserted the neutron never makes it from one fuel assembly to the other to cause a fission because it is absorbed in the control rod. Characteristic of the control rod is that it can absorb a neutron without fissioning. Without this fission chain reaction we get no heat. To start the fission chain reaction process, we can pull the rod out a short distance. By moving it only a short distance, the areas below the control rod can undergo the neutron bombardment to produce a chain reaction (see Figure X-10).

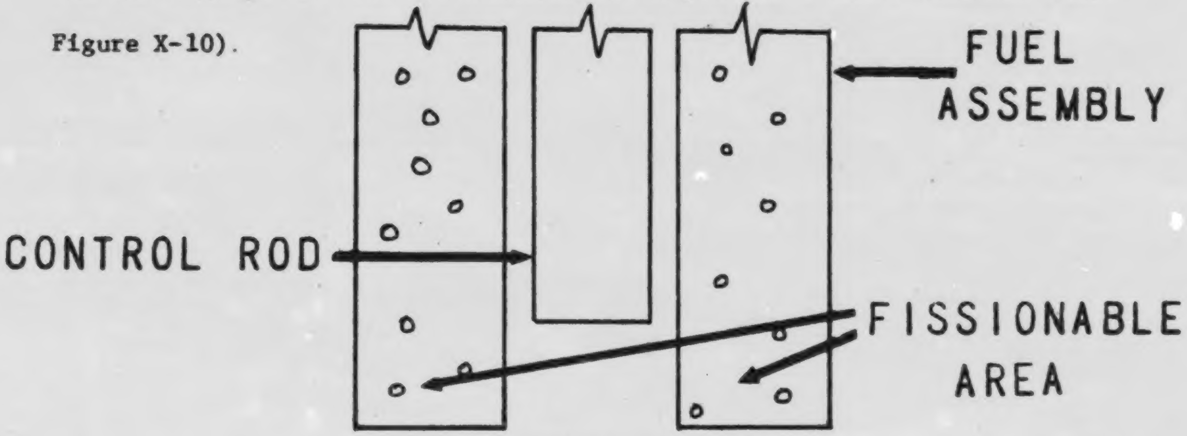


Figure X-10

Remember that water is used to carry away the heat and that is important. It also serves as a moderator (means of slowing down the neutrons). The moderator helps to increase the chances of a neutron striking the uranium and causing a fission. (See figure X-1)

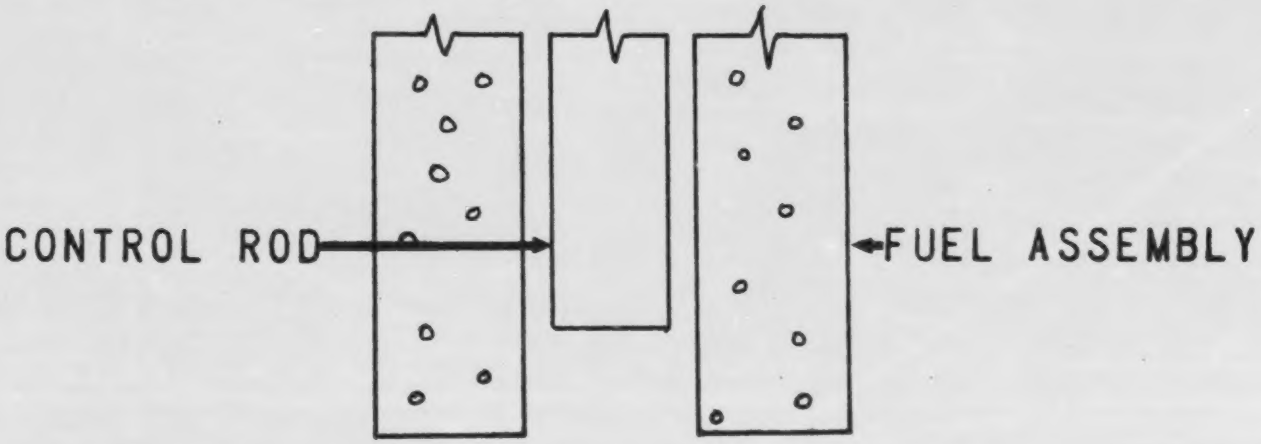


Figure X-11

In the production of electricity the control rod height controls the amount of heat delivered to the steam generator as the needed electrical amounts change.

The pressurizer is another component in the primary loop. Its function is to maintain the pressure necessary to keep the water in a liquid form. For the water to remove heat it must be in a liquid form. It should be understood that at 212°F water can be either a gas (steam) or liquid (water) and neither will get hotter unless pressure is applied. This principle is exemplified in a pressure cooker. When the pressure is increased on water to greater than atmospheric pressure, it takes a higher temperature for the water to boil. That is why you can cook things quicker in a pressure cooker--the water is at a higher temperature.

The fluid must have means of circulating to get the heat from the reactor to the steam generator; therefore, a coolant pump is used. The coolant pump is driven by an electric motor, usually a several thousand horse power. It is designed to raise the pressure of the water 100 pounds per square inch or greater to insure constant movement of water through the reactor, piping and steam generator.

The primary coolant system as a whole is made of stainless steel to reduce corrosion. The coolant flow through the reactor in an 800,000 KW reactor plant is about 2 million pounds per minute (330,000 gallons/minute). That is about the flow through 100,000 garden hoses.

The last item in the primary loop is the steam generator. Both the primary and secondary loops are connected to the steam generator; however, the systems are separate and water in the primary and secondary never come in contact with each other (see Figure X-12).

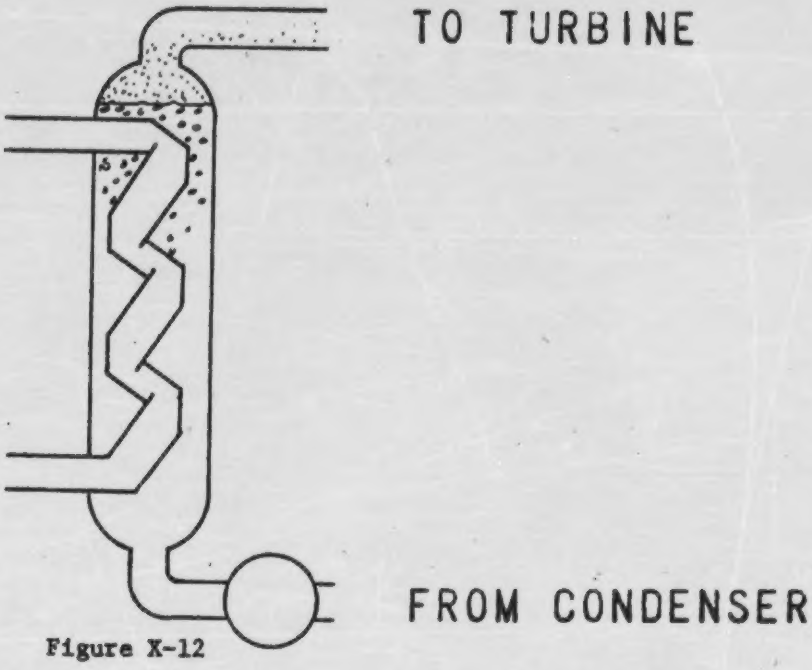


Figure X-12

The steam generator produces steam to turn the turbine generator. The primary coolant flows through tubes and heats the water on the secondary side. The water in the secondary systems is heated to a temperature very near that of the primary loop. Steam is formed. Like the pressure cooker, as steam is formed the pressure increases and, therefore, the temperature increases. The steam flows from the steam generator to the turbine generator where the steam is used to turn the turbine, thus producing electricity. The steam is directed from the turbine to a condenser. Basically, the condenser changes the steam to water. The process is very simple; almost the reverse of the steam generator process. The condenser is a huge heat exchanger which is shaped like a large cylinder (see Figure X-13).

Cooling water from lakes or rivers are pumped in one end of the condenser, through tubes and exit back to the lake or river. The steam comes in contact with the cool tubes in the condenser and the steam is changed to liquid again. The process is similar to the "sweat" formed on a glass of iced tea. The humidity is so high that where it comes in contact with the cool glass, condensation is formed and soon you have a ring of water at the base of the glass. The same basic principle holds true for the condenser.

From the condenser the lake water that is returned is at a higher temperature than the lake waters' normal temperature. At the present time this is a major concern of environmentalists. One solution predicated has been the use of cooling towers to cool the water before returning it to the lake.

After the steam has been turned to water, it is collected in the bottom of the condenser. Then, it is usually sent to a holding tank where it is preheated before sending it back to the steam generator for completion of the cycle.

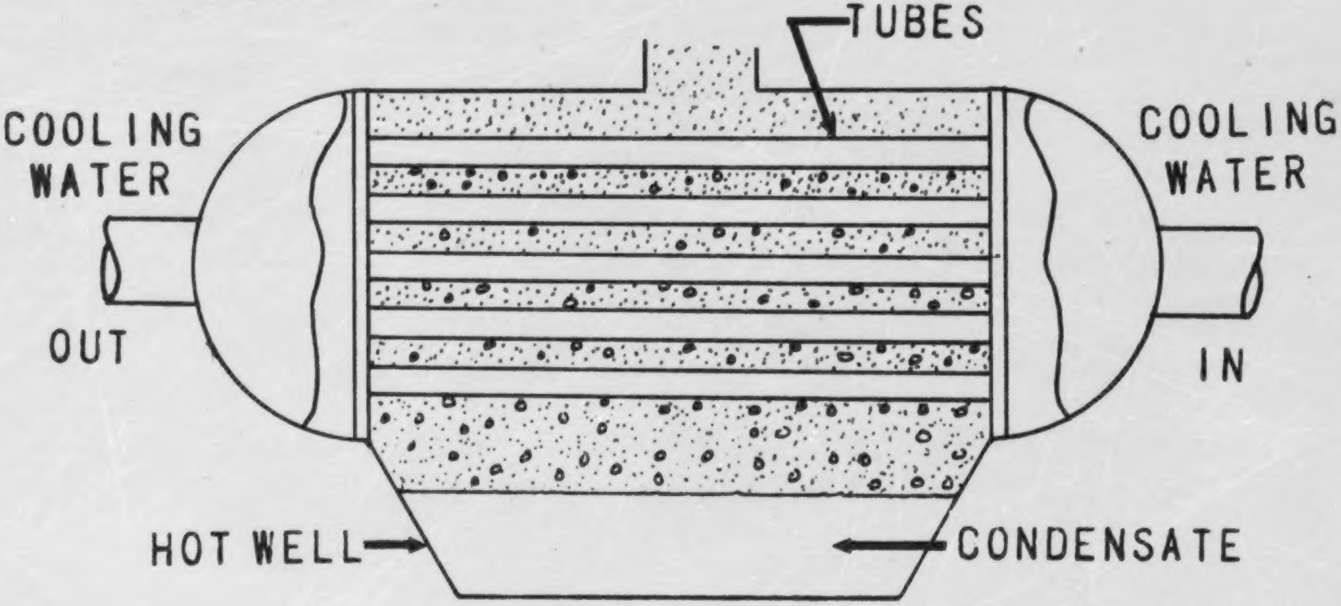


Figure X-13

Facts and Figures About Nuclear Energy

The energy shortage has concerned many people. Our oil is being used and no new reservoirs have been discovered. How can we continue to meet our energy needs of tomorrow? Solar power may be the answer, but that appears to be somewhat in the future. Other avenues are being considered. Nuclear power may bridge the energy crisis until other means of energy can be found. The possibility is real, and facts and figures have been published to prove that it can bridge that gap.

In April, 1976, 59 nuclear reactors supplied the United States with nearly 9% of the total electricity produced at that time. That is equivalent to burning one million barrels, 43 million gallons of oil per day. In 1974 the United States used 35.4 million barrels of oil per day. That is equivalent to 17,000 gallons of oil per second or 7 gallons of oil per day per person. The United States imported 20% of all its primary fuels in 1974, 44% of the total oil consumed and spent $24.8 billion for 7 million barrels of oil per day. The consumption rate is increasing. In 1973, the United States' imports amounted to $8 billion and $30 billion in 1975. The oil price increased during this time from $4 per barrel to $14 or $16 per barrel--approximately 30¢ per gallon for crude oil (not yet refined).

In 1975 nuclear energy saved the American people 500,000 barrels of oil per day. A single 1000 Mw nuclear power plant would save enough fuel to supply all the automobiles, trucks, buses, ships, trains and planes for a city the size of Dallas/Ft. Worth. Thirty 1000 Mw nuclear power plants would save, over a 40 year reactor plant lifetime, 10 billion barrels of oil, equivalent to all the oil contained in the Alaskan oil field. One hundred sixty-five (165) 1000 Mw nuclear power plants could save the United States 7 million barrels of oil per day, about the amount that is imported.

The public is raising questions about nuclear safety. Can a reactor cause a nuclear explosion? What is radiation? How can we make sure the radiation doesn't leak out? How much will it cost in dollars to build and operate a nuclear power generating plant?

The answer to the safety of nuclear power plants has to come from an informed knowledgeable public. The fear of a nuclear explosion has been around since the atomic bombs introduction at Hiroshima. Since that time people have been afraid of nuclear energy. But is there a real threat of nuclear explosion from a nuclear power plant? A lightweight reactor contains 5% or less fissionable fuel. An atomic bomb requires almost 100% fissionable fuel. The reactor fuel is dispersed (scattered) rather than concentrated as required for the atomic bomb.

What kind of threat does a nuclear power plant pose to the public? The basic complaint by anti-nuclear power activists has been the possible release of radiation to the public. Is there a real hazard with radiation release? To answer the question, first we have to understand what radiation is. Radiation is energy given off as neutrons, alpha, beta or gamma particles. If a person were to be exposed to radiation for any given length of time, the energy given off could be deposited in critical areas of the body. Radiation is measured in units of REM or MREM (one-thousandth of a REM). A REM is eighty-seven (87) ergs of energy deposited in one gram of soft body tissue. An erg is the energy amount required to raise a mosquito one centimeter (see Figure X-14).

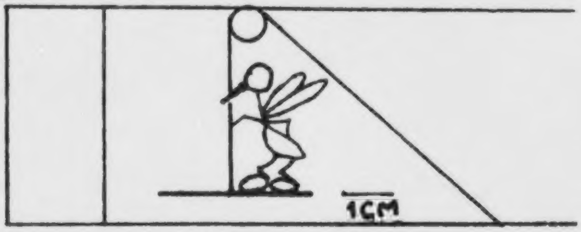


Figure X- 14

An equivalent amount of energy would be about 1/8 of the energy the body receives from eating one scoop of ice cream. However, the energy in four scoops of ice cream does not damage the body because the energy is distributed throughout the body to all cells. A REM, however, is per gram of soft body tissue. This is the danger involved with radiation.

Does nuclear power pose a real hazard to the public? Below are figures compiled on radiation sources and the amount of radiation the public receives.

Average Annual Radiation Doses (MREM)

Natural	
Sun, Rock, Soil, etc.	130
Man-made	
Medical diagnosis	72
Fallout from past nuclear weapons testing	4
Television	0.7
Commercial products	1.9
Air transportation	1.3
Commercial nuclear power	0.0003
Total	209.303

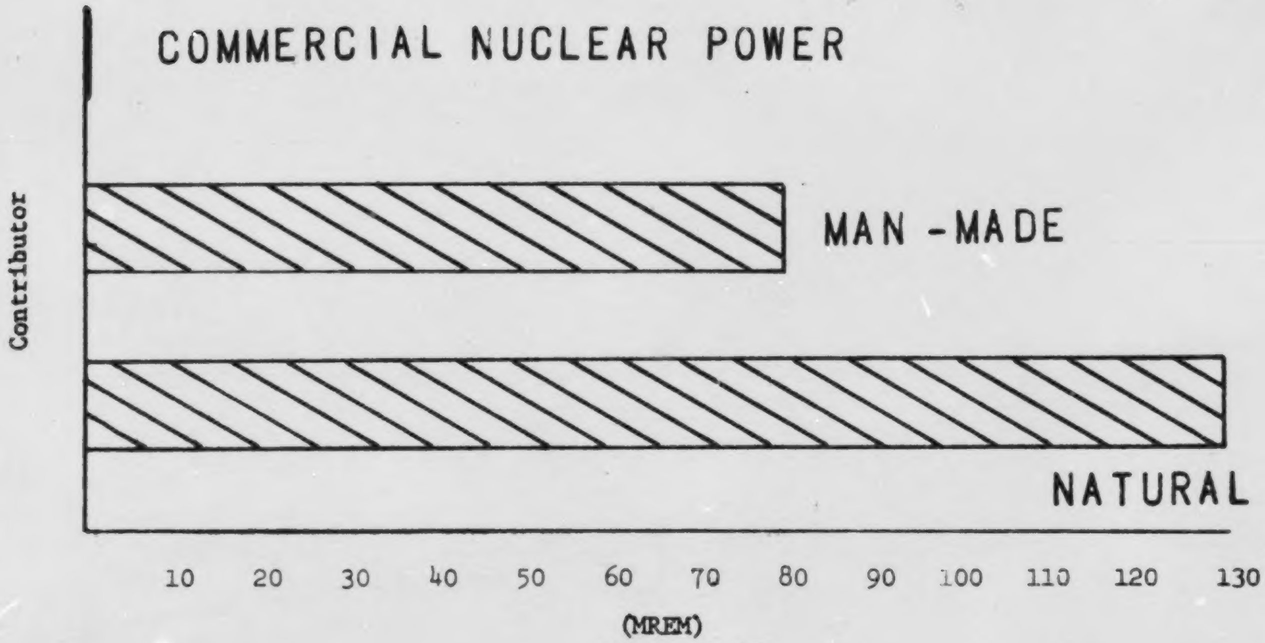


Figure X-15

What is the risk of a death due to nuclear power? The list below shows the probability of an individual being killed by various types of accidents.

Accident Type	Total Number	Individual Chance/Year
Motor vehicle	55,791	1 in 4,000
Falls	17,827	1 in 10,000
Fires and hot substances	7,451	1 in 25,000
Drownings	6,181	1 in 30,000
Firearms	2,309	1 in 100,000
Air travel	1,778	1 in 100,000
Falling objects	1,271	1 in 160,000
Electrocution	1,148	1 in 160,000
Lightning	160	1 in 2,000,000
Tornadoes	91	1 in 2,500,000
Hurricanes	93	1 in 2,500,000
All accidents	111,992	1 in 1,600
Nuclear reactor accidents (100 plants)	0	1 in 5,000,000,000 (estimated)

*ERDA Nuclear Energy

What are the environmental effects of a nuclear power generating plant? Nuclear plants are among the cleanest energy producing methods. The land used for the reactor, the fuel mining land, and waste disposal land, requires the least of all power producing plants. Also, there is no release of atmospheric chemical pollutants.

Thermal pollution by nuclear power plants has been the major concern of environmentalists. The heat discharged to rivers and lakes is slightly greater than fossil fuel plants. However, the total heat loss to the environment is about the same.

What is the cost of nuclear power? In 1974 nuclear power plants produced electricity 40% cheaper than fossil-fueled plants; therefore, saving the consumers $750 million. In 1975 savings due to the nuclear power amounted to $1.35 billion, 7.5 billion gallons of oil and 40 million tons of coal. In 1976 the savings amounted to 63%--about 37% of the cost of fossil fuels. The projected cost of coal in 1980 is 2.4 times as much as nuclear power, and oil 4.4 times as much.

An example of the cost comparison for nuclear power, coal and oil can be seen in the fuel costs for the first nine months of 1975 (see Figure X-16).

To operate each type of plant, fuel must be used. A comparison of the fuels indicate that for a typical 100 Mw plant the total oil required is 370 million gallons per year, 2.1 million tons of coal per year, and 85 tons of enriched uranium initially and 28 tons per year thereafter. Uranium fuel the size of a golf ball has the energy equivalent of 168,000 gallons of oil.

How safe has the industry been since its conception? The safety record for nuclear power is very impressive. Over thirty years of operating with 175 commercial and 1300 naval reactor years of operation no one has ever been killed or injured. Is nuclear power safe? Does it pose hazards to the environment? Do we really need it? These are questions that you must decide on.

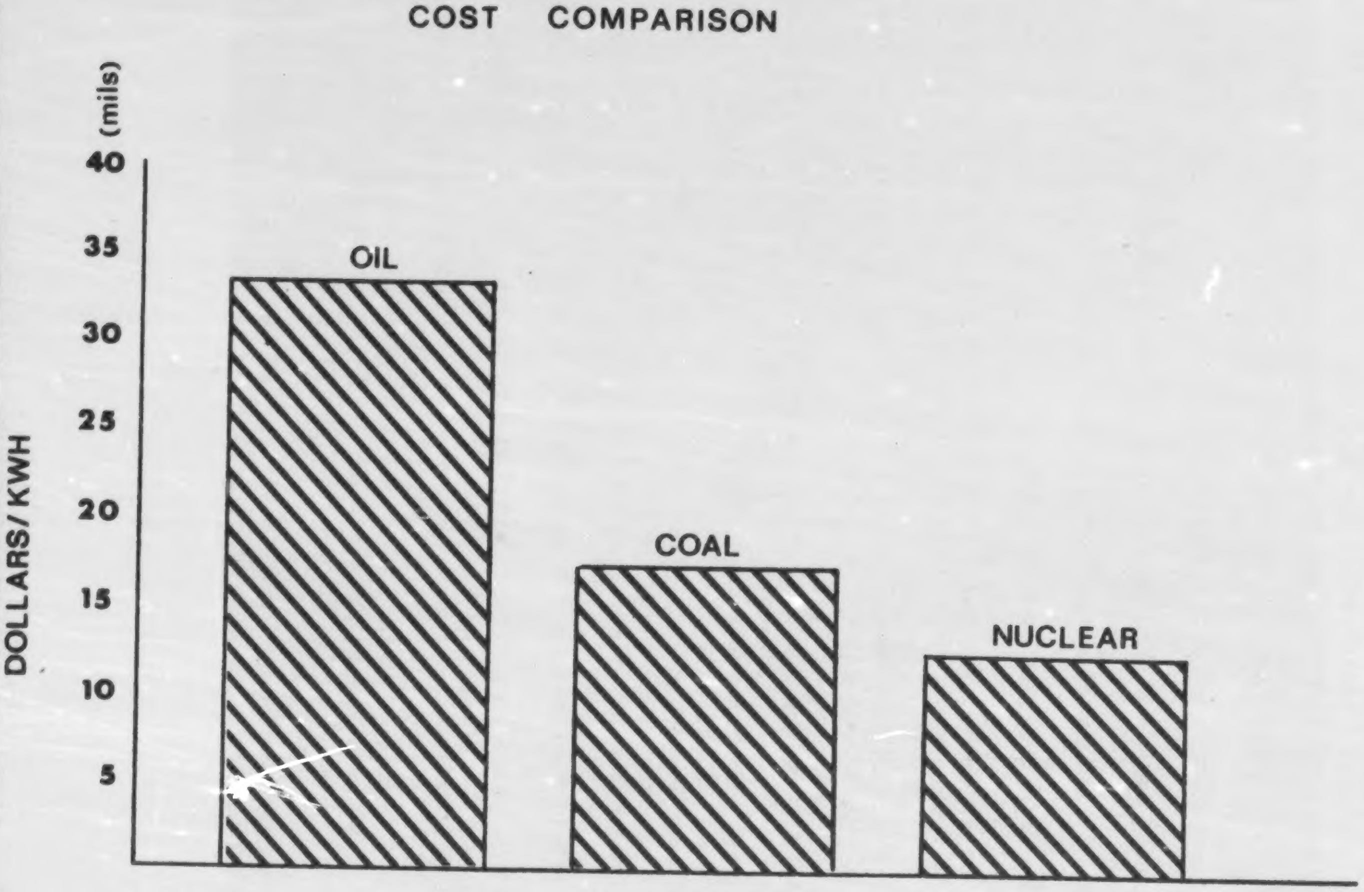

COST COMPARISON
DOLLARS/KWH (mils)
40
35
30
25
20
15
10
5
OIL
COAL
NUCLEAR

Figure X - 16

ACTIVITIES

1. Write a report on one of the following topics. Use resource materials in the library. Feel free to use graphics with your reports (Activity X-1).

   A. How a Nuclear Reaction Works

   B. The History of Nuclear Power

   C. The Pioneers of Nuclear Research (Einstein, Fermi, etc.)

   D. The Functions of each Component in a Nuclear Power Plant

   E. The Biological Effects of Radiation

2. Identify three heavy metals which can be used as fuels in fission reactors. Why are they used instead of other minerals? (Activity X-2).

3. Draw a diagram of a Water-Cooled Nuclear Fission Reactor. Include all of the major components (Activity X-3).

4. The quality of some nuclear power plants has been criticized lately. Write a brief article describing the real situation through research. The New York Times would be a good resource and other articles on this topic will help to give a clear picture of the problem (Activity X-4).

5. Make a campaign poster for or against nuclear power. Try to sell your views to your classmates (Activity X-5).

6. Complete the Nuclear Word Puzzle (Activity X-6).

7. Set up a debate on the pros and cons of nuclear power. Students may use pictures, diagrams, newspaper clippings, mimeograph sheets or any other media form to present their case (Activity X-7).

8. On the Texas map, shade in with watercolors, crayolas, or magic markers where uranium deposits can be found. Also, try to locate any facilities that are related to the nuclear industry (Activity X-8).

9. Define the vocabulary words (Activity X-9).

Nuclear Word Puzzle

(Activity X-6)

A list of words related to nuclear energy is given below the puzzle. Look for the words hidden in the puzzle. When you find one, circle it and mark it off the list until you have found all the words.

```
I S O P E T M E N J K U R O T A R E N E G O E P W R C O N E T U R O N B
W T E R C O J O D U L E C U L E O D C I T C P A R T O L O R M E U S R R
C P A M O S I M N E C L U R C I T Y A O L S O D B E O A R T E C I O T E
O R P S C S S O N O N L O T S U C M A T S O T C L E L I T O N M D S P E
G N T R S M A T O M S T E W Y H A N T O N O O W D O A G U N E L C U E D
U E M I E M C E I W O Q U U L H E A R G E N S W R B N M E R E A C O R E
H I F N E D N E U L E R E A S F R W D R S K I B W R T M N C R C L E G R
```

breeder

fission

atoms

nucleus

generator

reactor

isotope

PWR

BWR

coolant

neutron

REM

rod

Vocabulary

(Activity X-9)

1. breeder reactor -

2. control rod -

3. fission -

4. fuel cell -

5. graphite -

6. isotope -

7. liquid metal -

8. moderator -

9. plutonium -

10. primary coolant -

11. reactor -

12. REM -

13. thorium -

14. zircaloy -

SUGGESTIONS TO THE TEACHER

This chapter has been prepared as an introduction to nuclear energy. The material includes information on five different types of reactors and the basic parts of a nuclear reactor plant. Hopefully the students will be able to realize how relatively safe a nuclear reactor really is. Students will need to read and discuss the information section before attemptting the activities.

Most of the activities deal with opinionated issues. Nuclear power will be an ever more controversial issue in 10 - 20 years. School children should start building a knowledgeable base of nuclear information for the future. Let the pupils pick a report topic to report on. The reports can be written or given orally. Encourage the use of graphics and creativity in presentation. The answers to the second and third activities can be found in the information sections of the chapter. For Activity X-8, use the same Texas map that was used in Chapters II and III. Also, any of the drawings in the chapter can be made into models with a little cardboard, tape and paper. The debate should be used to stimulate discussion on nuclear power and future trends. The vocabulary list fosters comprehension.

List of Materials

Activity X-1

resource materials (articles, encyclopedias, books, pamphlets, etc.)

pen and paper

Activity X-2

pen and paper

Activity X-3

pen, paper, straight edge and diagram

Activity X-4

resource materials

pen and paper

Activity X-5

posterboard

magic markers

pencil

ruler

construction paper

glue, tape

crayolas, watercolors

Activity X-6

Nuclear Word Puzzle in hand-out form

pen or pencil

Activity X-7

resource materials

Activity X-8

Texas road map (used in Chapters II and III)

watercolors, crayolas, or magic markers

Activity X-9

Vocabulary list in hand-out form

pen or pencil

TEST

1. Draw and explain briefly the basic steam cycle. Label each component.

   Steam is formed at the heat source and transported to the turbine. The steam turns the turbine which turns the generator, producing electricity. From the turbine the steam is condensed to water in the condenser and pumped back to the heat source.

2. Discuss briefly what fission is.

   When a free neutron strikes the nucleus of a heavy atom and causes the heavy atom to split into two equal parts (usually).

3. Basically describe how fission causes heat which we use to power the turbine.

   When the heavy atom splits, the two resulting parts are charged particles and begin to cause ionizations (ripping off electrons to become stable again) that result in heat given off to the surrounding materials.

4. How does the heat get from the reactor to the steam generator and produce steam?

   The heated surroundings where the fission occurs conduct heat to the water running through the core and the water carries the heat to the steam generator.

5. Why is there so much research being done with breeder reactors?

   Breeder reactors can produce more fuel than they consume.

6. Which type of fuel is the least common found in nature and is used as an enriched fuel?

A. plutonium 239

B. uranium 238

C. thorium 233

* D. uranium 235

7. Which type of fuel does the breeder reactor use?

A. plutonium 239

* B. uranium 238

C. thorium 233

D. uranium 235

8. What type of fuel does the breeder reactor produce and is also used in making atomic bombs?

* A. plutonium 239

B. uranium 238

C. uranium 233

D. uranium 235

9. A REM is a unit of measure for

A. fuel

B. steam

* C. radiation

D. water

10. A nuclear bomb requires 100% fissionable fuel and a nuclear power plant has only ________%.

* A. 5%

B. 25%

C. 50%

D. 95%

11. Radiation is given off in the form of alpha, beta, gamma and

A. proton

B. electron

* C. neutron

D. ion

12. The chance of a person being killed from a nuclear reactor accident out of 100 nuclear reactor plants is

A. 1 in 500

B. 1 in 5,000

C. 1 in 50,000

* D. 1 in 5,000,000,000 (billion)

13. A golf ball size piece of uranium has the equivalent energy of about how many gallons of oil?

A. 150 gallons

B. 15,000 gallons

* C. 150,000 gallons

D. 1,500,000 gallons

14. Through the commercial and naval nuclear power history, how many people have been killed?

* A. 0

B. 2

C. 5

D. 6

15. Which type of electrical production cost more?

A. nuclear

* B. oil

C. coal

D. solar

Answers

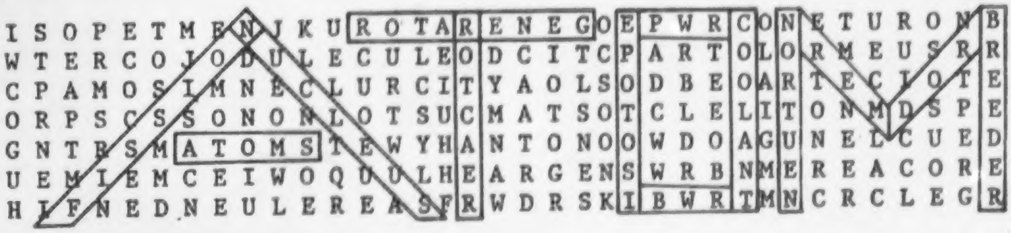
Activity X-2

Plutonium, thorium, and uranium. They are used instead of other minerals because plutonium and thorium are produced by a fast-breeder reactor, and uranium is the most abundant, useable radioactive mineral found in nature.

Activity X-3

Refer to Figure X-3 or Figure X-2

Activity X-6



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I S O P E T M E N J K U R O T A R E N E G O E P W R C O N E T U R O N B
W T E R C O J O D U L E C U L E O D C I T C P A R T O L O R M E U S R R
C P A M O S I M N E C L U R C I T Y A O L S O D B E O A R T E C I O T E
O R P S C S S O N O N L O T S U C M A T S O T C L E L I T O N M D S P E
G N T R S M A T O M S T E W Y H A N T O N O O W D O A G U N E L C U E D
U E M I E M C E I W O Q U U L H E A R G E N S W R B N M E R E A C O R E
H I F N E D N E U L E R E A S F R W D R S K I B W R T M N C R C L E G R
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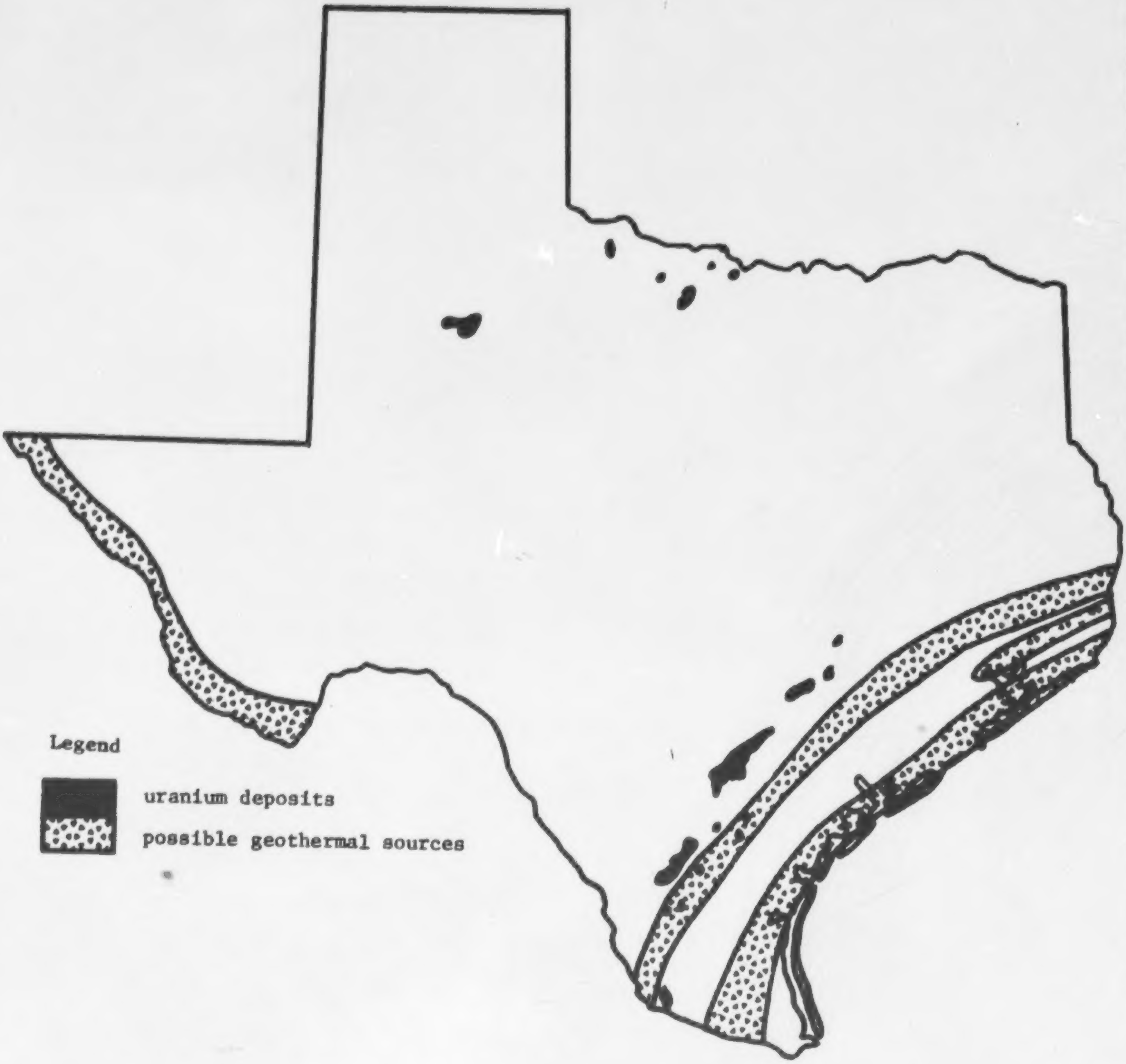
384

Answers: Activity X-8


Legend
■ uranium deposits
▨ possible geothermal sources

RESOURCE LIST

The following publications are available from Energy Research and Development Administration (ERDA), ERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

"Nuclear Energy"

"The Breeder Reactor"

"Shipping of Nuclear Wastes"

"How Probable is a Nuclear Accident?"

"Plutonium in the Environment"

"The Economics of Nuclear Power"

"Safeguarding of Nuclear Materials"

"Nuclear Power Plant Safety"

"High-level Radioactive Wastes from Nuclear Power Plants"

"Worlds Within Worlds: The Story of Nuclear Energy", Vol. 1, 2, and 3 by Isaac Asimov, 1972.

"Atomic Pioneers", Books 1, 2, and 3 by Ray and Roselyn Hiebert, 1974.

Lyerly, Ray L. and Walter Mitchell, III. Nuclear Power Plants. U.S. A.E.C. Office of Information Services.

The following films are available from ERDA, same address as above.

#0199	Man and Radiation (1963), 28 1/2 minutes, color
#0180	Introducing Atoms and Nuclear Energy (1963), 11 minutes, b/w or color
#450	Horizons Unlimited (1969), 37 minutes, color
#409	The Fifth Fuel (1967), 22 minutes, color
#0074	Basic Principles of Power Reactors (1962), 8 1/2 minutes, color
#0410	Atomic Power Today (1967), 15 minutes, color
#0429	The Atom and The Man on the Moon (1969), 13 minutes, color

#0001	A is for Atom, 15 minutes, color
#0507	Energy--The American Experience (1975), 28 1/2 minutes, color
#0141	The Fuel of the Future (1965), 29 minutes, black and white
#0449	Go Fission (1969), 14 minutes, color
#0408	Inside the Yankee Core (1967), 32 minutes, color
#0292	Radiation and the Population
#0447	Nuclear Power and the Environment (1969), 14 minutes, color
#0226	Nuclear Power and Space - SNAP 9A (1963), 12 minutes, color
#0468	Nuclear Power in the United States (1971), 28 minutes, color
#0496	On the Move (1974), 28 minutes, color (radioactive shipping)
#0256	The Petrified River (1956), 28 minutes, color (uranium mining)

ENCORE

Chapter 11

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. tell whether given drawings of wind machines are of the vertical axis, horizontal axis or translational type.
2. tell whether given drawings of wind machines' operation are based on the principal of lift, drag or a combination of the two.
3. match correctly the names of various types of machines with drawings of same.
4. construct a simple anemometer that can be used to measure wind speeds.
5. measure and record wind speeds in his/her neighborhood and determine average wind speeds for a specified month.
6. plot the average wind speeds on a map of the surrounding area, and determine where it would be most feasible to construct a wind energy conversion system.
7. determine the effect of the energy produced by wind generators with rotors of differing size and type and at different wind speeds, using a wind tunnel.

HARNESSING THE WIND

We cannot begin to replenish the stored energy of the earth quickly enough to meet future energy use levels. Ninety-six percent of the U.S. energy is now produced by fossil fuels and the fossil fuels are being used up rapidly.

A growing number of scientists seek to harness the constant, dependable renewable energy of the sun to heat and cool buildings as well as to produce electricity. One concentrated by-product of solar energy is the wind. In the 1920's and 1930's, before the power companies ran their lines into many rural areas, wind power had a brief popularity. Some 50,000 small wind machines each producing three to ten kilowatts were sold to people living in the United States. Most of the generators were taken down or allowed to rust when rural electrification became available.

Today sales are booming again. People are buying small wind generators as fast as they can be manufactured. Energy planners in government and industry are taking windmills very seriously.

During the past 40 years, the Russians, Danes, Germans and British have built large windmills in search of a low-cost design for a wind energy conversion system (WECS). The most massive experimental windmill was American-made, built during World War II on Grandpa's Knob, a hill outside Rutland, Vermont. The machine was 110 feet high, and the two blades of the propeller, joined at the hub, together were 175 feet long. This was not the only large system attempted. All of these experimental efforts dating back to the 1930's worked, proving their technical feasibility. Currently, the capital cost per KW for high performance WECS is too high to compete with most other forms of energy. However, the continuous increase in costs for fossil fuels added to research findings for lower WECS costs will soon make wind generators economically feasible. Advantages of WECS are summarized below:

a. Feasible alternative source

b. Non-depletable supply

c. Independent of foreign sources

d. Exportable technology and products

e. Moderate sophistication

f. Low environmental impact (no pollution)

The Effect of Wind Speed and Rotor Size

When the wind velocity increases, the power derived from the wind increases. To find out how much the power increases, divide the second wind speed by the first wind speed and cube the results. For example, on Tuesday the wind speed is 10 mph and on Wednesday it is 20 mph. What is the difference in the amount of power that could be produced on Wednesday?

$$\left(\frac{20 \text{ mph}}{10 \text{ mph}}\right)^3 = (2)^3 = 8$$

There would be eight times as much power available on Wednesday as there was on Tuesday.

Also, when the blade (or propeller) diameter increases, the power increases. To find the power increase, divide the larger blade diameter by the smaller blade diameter and square that fraction. For example, a 200 ft. blade will produce $(2)^2$ or 4 times the amount of power as a 100 ft. blade.

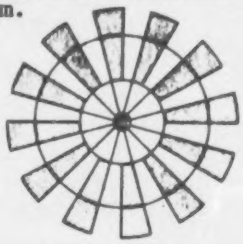
$$\left(\frac{200 \text{ ft.}}{100 \text{ ft.}}\right)^2 = (2)^2 = 4$$

An increase in the number of blades will provide more turning force at low speeds. This concept is used for water pumping. Fewer blades provide more energy for their cost. In small wind machines with blades 20 to 40 feet in diameter, three blades are probably best in terms of cost and balance. In larger wind turbines two blades are better.

Types of Wind Energy Conversion Systems

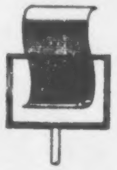
Machines with rotors

1. Horizontal axis rotors (head-on): the axis of rotation is parallel to the windstream.

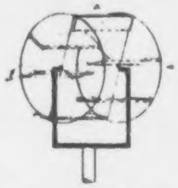


U.S. Farm Windmill
Multi-Bladed

2. Cross-wind horizontal axis rotors: the axis of rotation is both horizontal to the surface of the earth and perpendicular to the direction of the windstream, somewhat like a waterwheel. Not very effective.

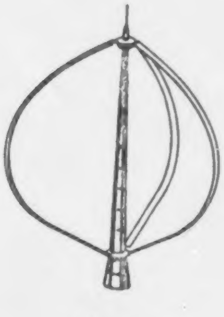


Cross-wind Savonius

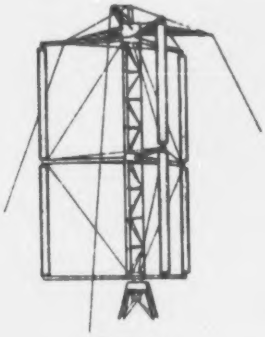


Cross-wind Paddles

3. Vertical-axis rotors: the axis of rotation is perpendicular to both the surface of the earth and the windstream.



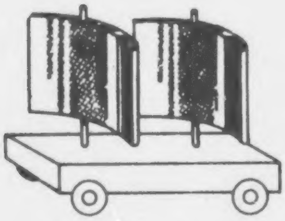
ϕ-Darrieus



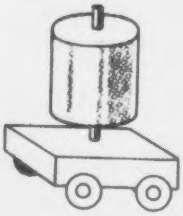
Giromill

Translational wind machines

1. Sailing ships
2. Sailing ships that carry water-driven turbines mechanically connected to an electric generator.
3. Land vehicles driven by sails or solid airfoils on a closed track or roadway with their wheels mechanically linked to an electric generator.



Airfoil

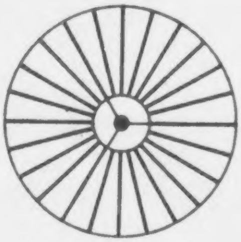


Magnus

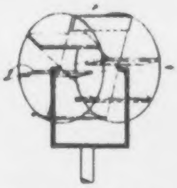
Horizontal axis rotors

1. Can be either lift or drag devices.

LIFT-TYPE



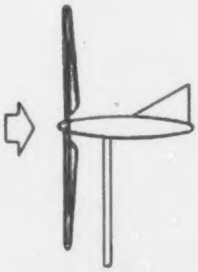
Bicycle Multi-Bladed



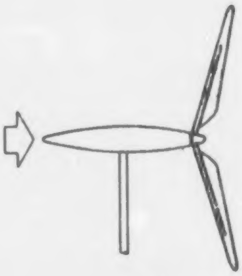
Cross-wind Paddles

DRAG-TYPE

2. May be either up-wind or down-wind rotors.



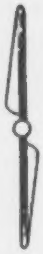
Up-Wind

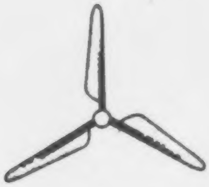


Down-Wind

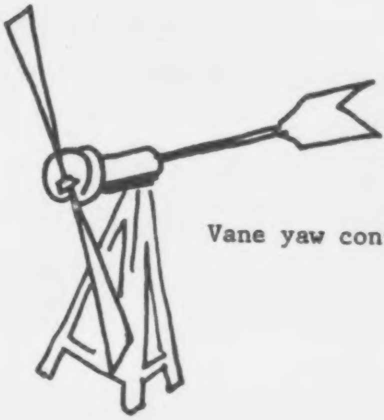
3. Can be designed with different numbers of blades, ranging from one-bladed devices with a counterweight, to devices with large number of blades.

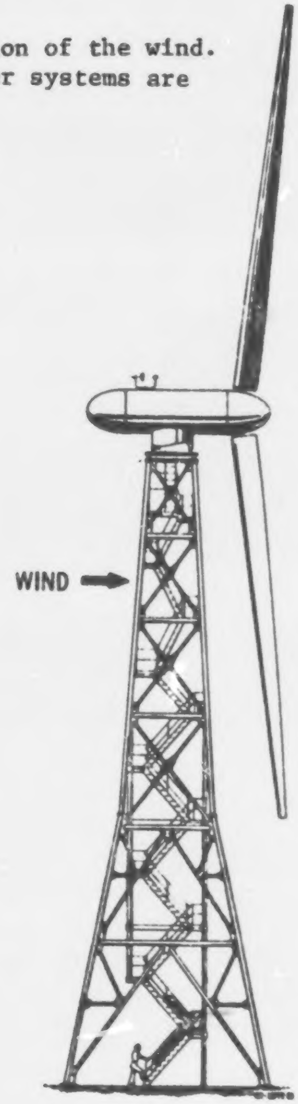
Single-Bladed


Double-Bladed


Three-Bladed

4. May be either yaw-fixed or yaw-active.
   a. Yaw-fixed cannot be rotated into the wind--used where prevailing winds are from one direction.
   b. Yaw-active will "track" the changing direction of the wind. Small systems use a tail-vane, whereas larger systems are normally servo controlled.


Vane yaw control



Servo yaw control

5. Propeller speed control (overspeed protection)

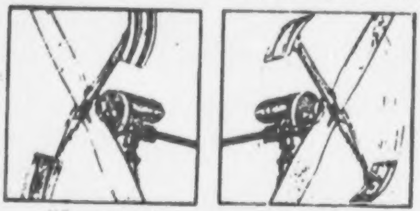
   a. Changing the pitch of the blades.

   b. Flap rotating with the blades.

   c. Flaps on the blades.

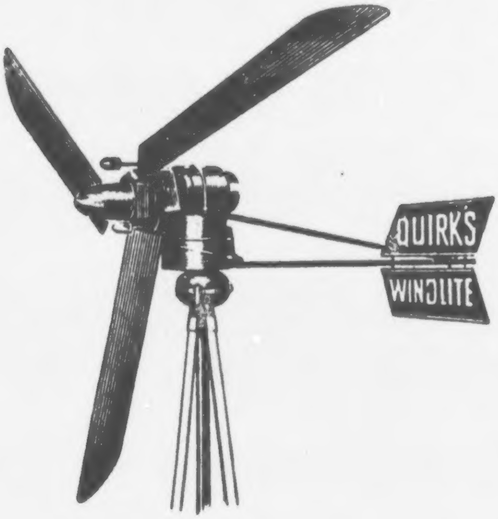
   d. Devices that turn the propeller sideways to the wind.

PATENTED AIR-BRAKE GOVENOR



"Governing" "Normal"

Operates by centrifugal force. When wind velocity exceeds 23 miles per hour, governor flaps automatically open and spread wind away from propeller (See illustration). Governor also acts as a fly wheel to maintain even propeller speed and eliminate vibration in gusty wind.



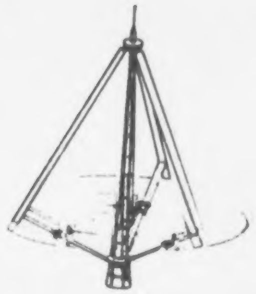
Three-blade wind-driven power plant, with automatic, variable-pitch propeller.

6. Drive, or power output

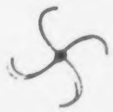
   a. Direct coupling to rotor shaft.

   b. Circular rim attached to blade tips to drive a secondary shaft connected to generator or power output.

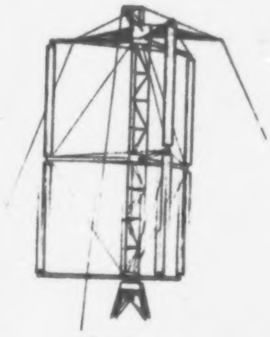
Vertical-axis rotors



Δ-Darrieus



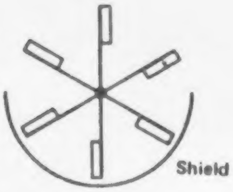
Multi-Bladed Savonius



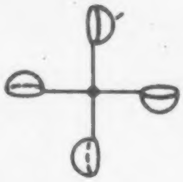
Giromill

1. Major advantage over horizontal-axis rotors is that they do not have to be turned into the wind as the direction of the windstream varies.

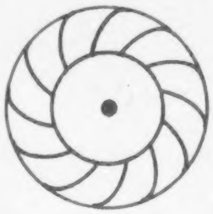
2. Those that use plates, cups or turbines are drag devices.



Plates



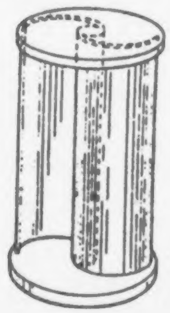
Cupped



Turbine

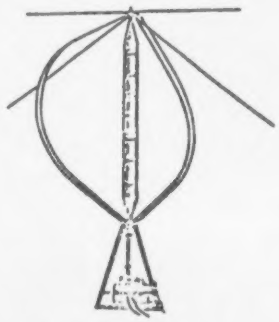
3. Savonius and Darrieus type rotors are lift type devices.

SAVONIUS ROTOR



CHARACTERISTICS:
- Self-Starting
- Low Speed
- Low Efficiency

DARRIEUS ROTOR



CHARACTERISTICS:
- Not Self-Starting
- High Speed
- High Efficiency
- Potentially Low Capital Cost

ACTIVITIES

1. By studying the pictures on the hand-outs, decide whether each wind machine is a lift, drag or combination type of machine. Also, decide whether each machine has a horizontal, vertical or translational axis (Activity XI-1).

2. By referring to the information section in this chapter, match the names of the wind machines with the correct pictures (Activity XI-2).

3. Construct an anemometer according to the instructions (Activity XI-3).

4. Measure wind speeds near your own home for a week or so. Record all your data on the record sheet provided. From your measurements, determine the average wind speed (Activity XI-4).

5. On a map of your town, plot the average wind speeds found in Activity XI-4 (Activity XI-5).

6. Construct a wind tunnel according to the instructions provided.

7. Using the wind tunnel, determine the differences in the amount of energy produced with wind speeds of 5 mph, 10 mph, and 15 mph using the same rotor sizes all three times (Activity XI-7).

8. Using the wind tunnel, determine the differences in the amount of energy produced using a 5 inch diameter rotor and a 10 inch diameter rotor with a constant wind speed (Activity XI-8).

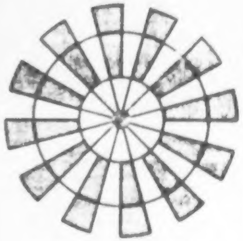
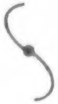
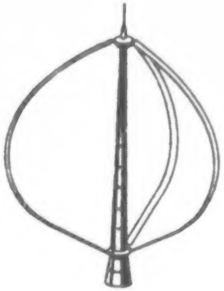
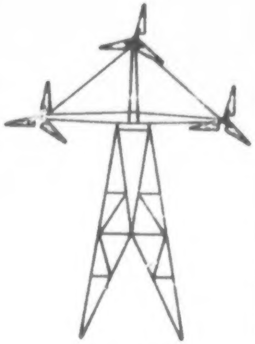
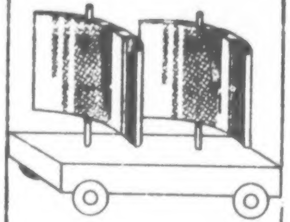
9. Solve the Wind Energy Problems (Activity XI-9).

10. Define the vocabulary words (Activity XI-10).

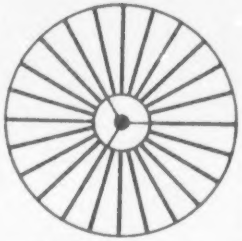
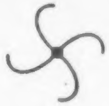
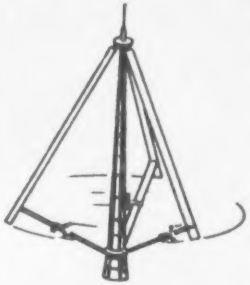
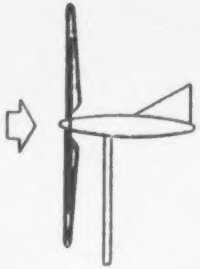
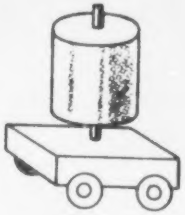
Activity XI-1

Instructions:

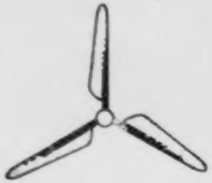
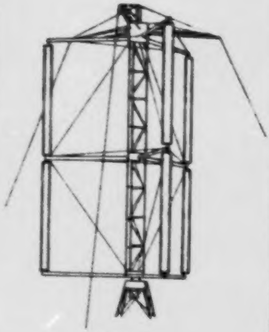
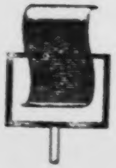
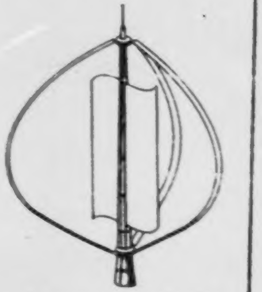
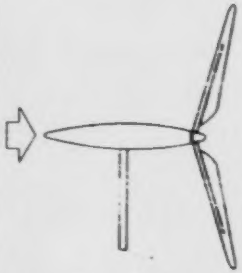
For both groups of descripters in the left hand column place a check mark in the appropriate box below each wind machine that best describes it.

	 U.S. Farm Windmill Multi-Bladed	 Savonius	 ϕ-Darrieus	 Multi-Rotor	 Airfoil
LIFT TYPE					
DRAG TYPE					
COMBINATION					

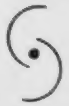
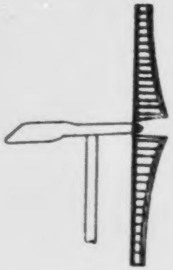
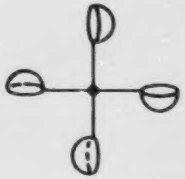
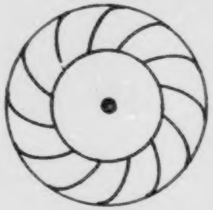
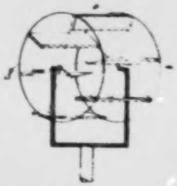
HORIZONTAL AXIS					
VERTICAL AXIS					
TRANSLATIONAL					

	 Bicycle Multi-Bladed	 Multi-Bladed Savonius	 Δ-Darrieus	 Up-Wind	 Magnus
LIFT TYPE					
DRAG TYPE					
COMBINATION					

HORIZONTAL AXIS					
VERTICAL AXIS					
TRANSLATIONAL					

	 Three-Bladed	 Giromill	 Cross-wind Savonius	 Savonius/ϕ-Darrieus	 Down-Wind
LIFT TYPE					
DRAG TYPE					
COMBINATION					

HORIZONTAL AXIS					
VERTICAL AXIS					
TRANSLATIONAL					

	 Split Savonius	 Sail Wing	 Cupped	 Turbine	 Cross-wind Paddles
LIFT TYPE					
DRAG TYPE					
COMBINATION					

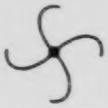
HORIZONTAL AXIS					
VERTICAL AXIS					
TRANSLATIONAL					

Activity XI-2

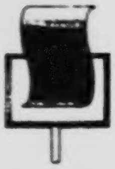
Identify the wind machines shown in the pictures by placing the correct letter from the column of names below each picture in the space provided.

NAMES

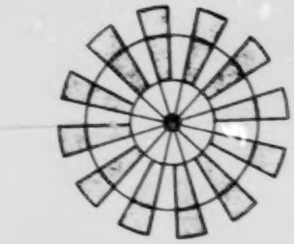
A. U.S. Farm Windmill
B. O Darrieus
C. Megnus
D. Turbine
E. Counter-rotating blades
F. Giromill
G. Cross-wind savonius
H. Darrieus
I. Airfoil
J. Multi-rotor
K. Savonius
L. Double-bladed



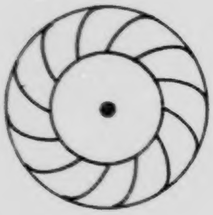
1. ____



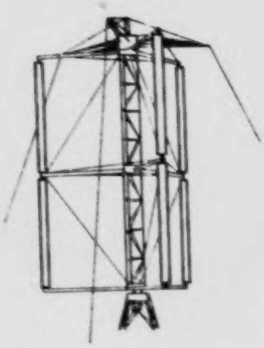
2. ____



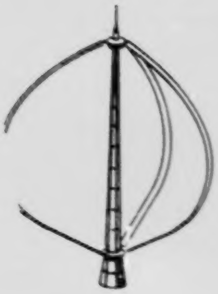
3. ____



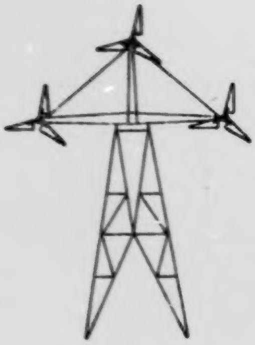
4. ____



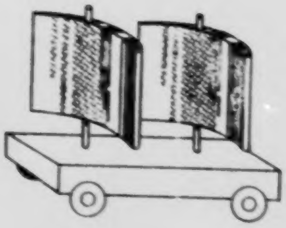
5. ____



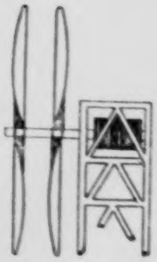
6. ____



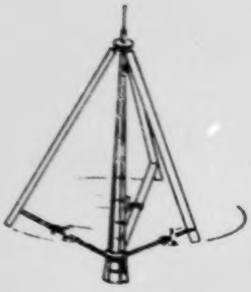
7. ____



8. ____

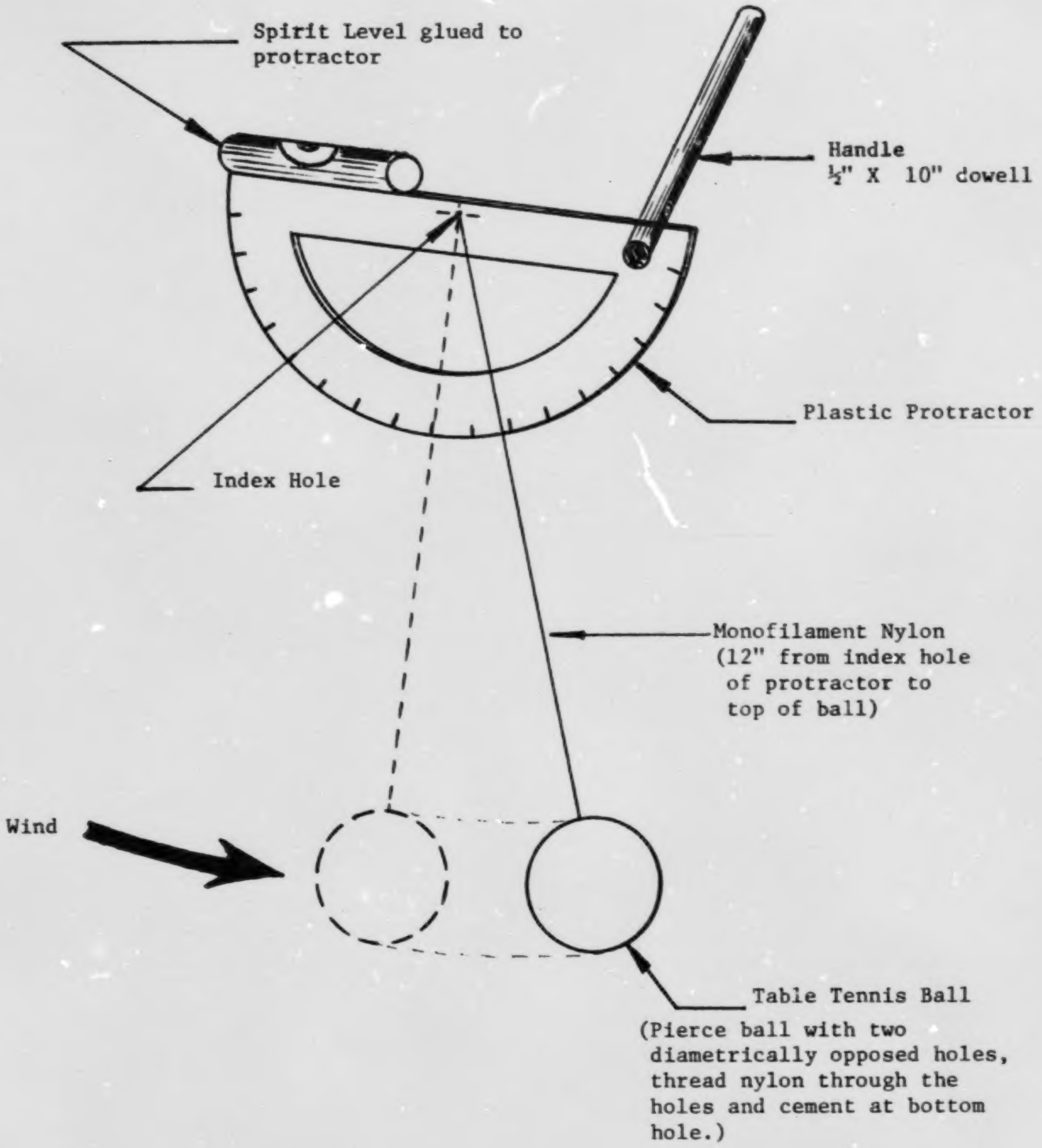


9. ____



10. ____

Activity XI-3


Spirit Level glued to protractor
Handle
½" X 10" dowell
Plastic Protractor
Index Hole
Monofilament Nylon
(12" from index hole of protractor to top of ball)
Wind
Table Tennis Ball
(Pierce ball with two diametrically opposed holes, thread nylon through the holes and cement at bottom hole.)

WIND VELOCITY METER
(Anemometer)

Record of Wind Speed Measurement

Activity XI-4

Measurements taken and recorded by: ______________________________

Address where measurements taken: ______________________________

Measurements taken during month of ____________________

Date	Time of Day	Protracter Angle	Wind Speed (mph)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			

Angle	Miles Per Hour
90	0
85	5.80
80	8.23
75	10.1
70	11.8
65	13.4
60	14.9
55	16.4
50	18.0
45	19.6
40	21.4
35	23.4
30	25.8
25	28.7
20	32.5

To find the average wind speed add all of the wind speed measurements and divide this total by the total number of observations made. Example: If the total of all wind speed measurements was 330, and this was the result of 30 observations during the month, the average wind speed for that month would be: $\frac{330}{30}$ = 11 mph. What is the average wind speed for your area? ________

Activity XI-6

Wind Tunnel Assembly Instructions

The blower used in this wind tunnel is a standard furnace blower, and it should be possible to obtain one from your local plumbing-heating contractor for a reasonable price if you specify a used one and tell him what you are going to use it for. The motor can be almost any 1/6 to 1/2 horsepower, 115 volt unit. The ratio of the sizes of the pulleys will depend on the output speed and power of the motor and the rated speed of the blower.

The first step in assembly is to cut out the front, back, top, and bottom pieces from 3/4" plywood. These pieces should be cut out carefully so they will match up properly when attached to each other. Sand the four pieces on all sides and then nail them together to form the tunnel body as shown in the plans. Use 6d finishing nails, and apply white glue to the joint before pressing the wood together and nailing. Support the tunnel body during this operation to insure that it remains perfectly square.

Paint the inside and outside of the tunnel with enamel paint. Be especially careful to give the inside of the tunnel a smooth finish to reduce turbulence and give a more even air flow.

Nail four pieces of quarter round moulding into the tunnel to form the rear (blower end) frame for the screen as shown in the plans. Press the screen into position and nail the other four pieces of moulding into place to form the front frame. (The screen should be nailed in place without any moulding if minimum turbulence is desired.)

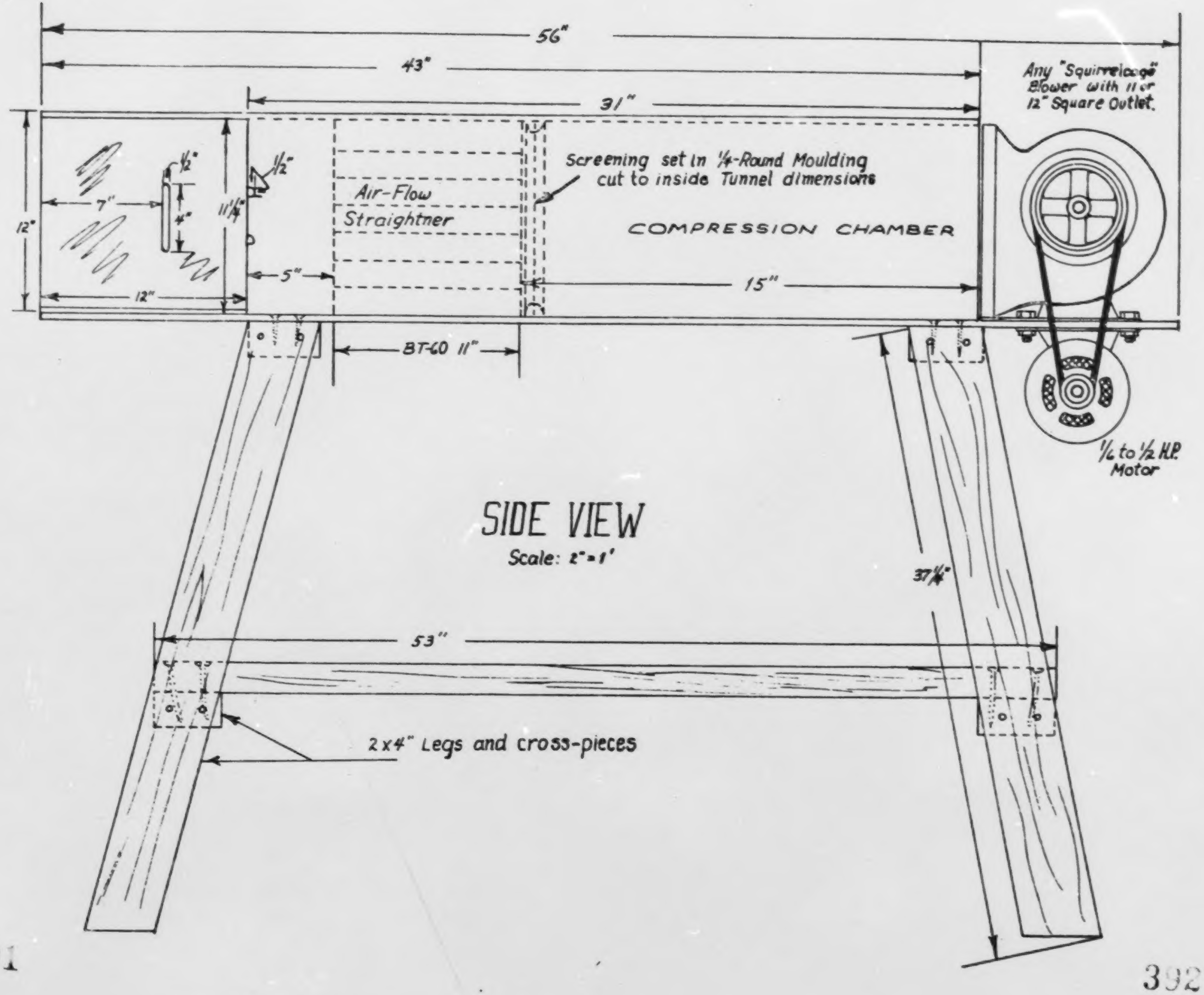
Cut and drill the bottom piece to match the mounting holes of the blower and the motor. Be sure that the holes are drilled to position the blower firmly against the rear of the tunnel. The blower should be adjusted so the flow is as even as possible.

Cut, miter, and sand the 2 x 4 pieces for the tunnel stand. Nail the stand together using 16d nails. Nail the stand and the tunnel together, then paint the stand.

Mount the blower, motor, and belt at the rear of the tunnel. The exact mounting procedure will vary with the type of motor and blower. Make sure the belt has a firm grip against the pulleys on both blower and motor.

Put the flow straightener tubes in place in the tunnel. These tubes should have a thin wall, and either metal tubing or BT-60 may be used. When all tubes are in place the assembly should make a tight press fit inside the tunnel body. (There are several other possibilities for the flow straightener. It may, for example, be made from heavy posterboard arranged to form a rectangular grid.)

Make a belt guard to keep fingers out of the moving parts of the wind tunnel. This guard should be designed to fit the pulleys and belt used on your wind tunnel, and may be made from sheet metal, cardboard, plywood, or other materials which may be available. Attach the aluminum window channel at the front of the tunnel. Slide the plexiglas window into place, and the wind tunnel is completed.


56"
43"
31"
Any "Squirrelcage" Blower with 11 or 12" Square Outlet.
1/2"
1/2"
12"
7"
4"
11 1/4"
Air-Flow Straightner
Screening set in 1/4-Round Moulding cut to inside Tunnel dimensions
COMPRESSION CHAMBER
5"
15"
12"
BT-60 11"
1/6 to 1/2 H.P. Motor
37 1/4"
53"
2x4" Legs and cross-pieces

SIDE VIEW

Scale: 2"=1'

Wind Energy Problems

(Activity XI-9)

1. Write down the two equations concerning wind velocity increase and blade diameter increase. Use them to answer the two following questions.

2. What are the different amounts of power produced by a 5 mph wind, a 10 mph wind and a 15 mph wind, using the same size rotor? Assume that a 5 mph wind produces 10 watts.

3. If the wind was blowing at a constant speed, what differences would there be in the energy production if you switched from a 5 inch rotor to a 10 inch rotor?

Vocabulary

(Activity XI-10)

1. anemometer -

2. drag-type wind machine -

3. horizontal axis -

4. lift-type wind machine -

5. pitch -

6. rotor -

7. translational -

8. vertical axis -

9. WECS -

10. wind tunnel -

11. yaw -

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide introductory material on wind power and various wind machines. The included activities have been selected to insure understanding of the basic concepts related to wind power. Students will need to read and discuss the information section before beginning the activities.

The first two sets of hand-outs are a comprehensive review of the factual information. Constructing an anemometer and using it to determine the wind speeds of their own locale enables the students to conceptualize the possibility of using wind power right at their own home. Completing the wind tunnel and the various experiments provided show the effects of wind speed and rotor size. The vocabulary list fosters comprehension.

List of Materials

Activity XI-1

hand-outs and pen or pencil

Activity XI-2

hand-outs and pen or pencil

Activity XI-3

one table tennis ball, spirit level, protractor, one dowel (1/2" X 10")) 12" of monofilament nylon

Activity XI-4

anemometer, data sheets, pen or pencil

Activity XI-5

town map, results from Activity XI-4, pen, magic marker, or crayola

Activity XI-6

furnace blower, 4' X 8' sheet of 3/4" plywood, 1 pound box of 6d finishing nails, 60" quarter round moulding, 1 quart of paint, hand saw, portable drill, miter box, sandpaper, 1 pound box of 16d nails, V belt to fit motor, 1/6 - 1/2 HP motor, 24' of 2" X 4" pine, 2 large cardboard boxes, 11 1/4 square piece of 1/8" plexiglass, and aluminum window channeling

Activity XI-7

the wind tunnel, hobby motor DC (to be used as generator, or bicycle generator may be used), 5" model airplane propeller (plastic or wood), 10" model airplane propeller (plastic or wood), various other rotor types (teacher constructed), stand (teacher constructed) suitable for mounting generator and propeller (center line of drive shaft should be at center line of wind tunnel), meter, 0-1 DC mA, 10,000 potentiometer, and bell wire

Activity XI-9

hand-out for Wind Energy Problems and pen or pencil

Activity XI-10

hand-out of vocabulary list and pen or pencil

Answers

Activity XI-1

	Lift	Drag	Combination	Horizontal	Vertical	Translational
U. S. Farm Windmill	X			X		
Savonius		X			X	
Ø-Darrieus	X				X	
Multi-Rotor	X			X		
Airfoil			X			X
Bicycle Multi-Bladed	X			X		
Multi-Bladed Savonius		X			X	
△-Darrieus	X				X	
Up-Wind	X			X		
Megnus			X			X
Three Bladed	X			X		
Giromill	X				X	
Cross-Wind Savonius		X			X	
Savonius/Ø-Darrieus			X		X	
Down-Wind	X			X		
Split Savonius			X		X	
Sail Wing	X			X		
Cupped		X			X	
Turbine	X				X	
Cross-Wind Paddles	X			X		

Answers: Activity XI-2

1. K
2. G
3. A
4. D
5. F
6. B
7. J
8. I
9. E
10. H

TEST

1. The most massive experimental windmill was built during

   * A. 1940's

   B. 1950's

   C. 1960's

   D. 1970's

2. The primary reason for wind energy conversion systems lack of competition is

   * A. cost per KW is too high

   B. not reliable

   C. environmentalist opposition

   D. lack of high strength blade metals

3. If the diameter of a rotor blade is doubled, how much does the power increase?

   A. 2 times as much

   * B. 4 times as much

   C. 8 times as much

   D. doesn't increase at all

4. A general rule might be that the larger the turbine

   A. more blades are needed

   * B. fewer blades are needed

   C. bigger blades are needed

   D. smaller blades are needed

5. If the wind speed doubles, how much will power from a wind turbine generator increase:

   A. 2 times as much

   B. 4 times as much

   * C. 8 times as much

   D. will not increase

6. There are three types of machines with rotors: the horizontal-axis rotor, vertical-axis rotor, and the

A. translational axis rotor

B. yaw active axis rotor

* C. cross-wind horizontal axis rotor

D. circular-wind axis rotor

7. The least effective of the three basic types of wind machines with rotors is the

A. horizontal axis rotor

B. vertical axis rotor

* C. cross-wind horizontal axis rotor

D. translational axis rotor

8. Savonius and Darrieus type rotors are

A. drag devices

B. translational devices

C. horizontal axis devices

* D. lift devices

9. The major advantage of vertical axis rotors over horizontal axis rotors is

* A. they do not have to be turned into the wind

B. they have to be turned into the wind

C. their wheels have to be mechanically linked to an electric generator

D. they must be servo controlled

10. Yaw-fixed wind devices

A. cannot be servo controlled

* B. cannot be rotated into the wind

C. cannot use a tail-vane

D. cannot have more than three blades

RESOURCE LIST

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"Wind Power," Popular Science, March 1975, p. 82.

ENCORE

Chapter 12

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. construct a simple fuel cell.
2. define a list of vocabulary words related to unusual energy sources.
3. express in a written paper his opinions on future sources of energy.

UNUSUAL ENERGY SOURCES

Solar, nuclear, wind, and the conventional sources of energy have already been discussed. With the exclusion of the wind, these sources will probably provide us with energy and electricity for the near future. But, there are several other sources of energy that should be discussed. Obtaining energy from organic waste, oceans, direct conversion, nuclear fusion, and from geothermal sources is feasible. These sources of energy are relatively new and they have not had much public exposure. These newer sources of energy, with further research, could possibly help alleviate the energy shortage in the future. It is very possible that the present school-age generation will still be around when these newer energy sources are commonplace. It is necessary to study these energy sources now, so our background will be broad enough to make the proper decisions on energy choices in the future.

Energy from Organic and Municipal Waste

Producing energy from waste (energy farming) is still in the research stage. Researchers hope to develop fast-growing plants that will produce useful by-products. Converting wasted organic matter (plants) into clean fuels or other energy products can be divided into four basic processes: 1) biological, 2) thermochemical, 3) combustion, and 4) biophotolysis.

Biological processes include fermentation, which could produce methane and alcohol. In fermentation bacteria are isolated for use in methane production from organic and municipal waste. Animals are natural methane producers. A cow has the bacteria, *methanum bacterium rumenium*, in her rumen fluid. It has been said that "10 cows burp enough gas in a year to provide for all the space heating, water heating and cooling requirements for a small house." Now we do not recommend burp bags for cows, but we do know that the bacteria from their rumen, after waste has been broken down by other bacteria, can be used to make methane from feed and hog lot wastes--enough perhaps to generate on-site electricity for feed grinding and home heating for the individual farmer with fertilizer as a by-product. This can be done with "organic waste digesters". Two types of organic waste digesters are used to speed the fermentation process. The first is a batch-load digester which is filled, sealed, and emptied when the raw material has stopped producing gas. The second is a continuous load digester, which is fed a little raw material regularly so gas and fertilizer are produced continuously. Each load progresses down the length of the digester to a point where methane bacteria are active. Gas rises to the surface and can be removed to be burned directly for heat and light, stored for future use, or compressed to power heat engines.

Thermochemical processes include catalytic gasification which could produce methanol. It also includes pyrolitic conversion of solid waste. Heating solid waste causes chemical changes which produces a fuel-like gas or an oil-like liquid to provide electricity or other forms of energy. Forest residues have already produced energy to run sawmills and pulping processes. During World War II, France's liquid fuel supply consisted of methanol manufactured from wood feedstock.

Other biomass (agricultural wastes and energy crops) may be produced from Eucalptus, sycamore, fast-growing sea kelp, sugar cane, sunflowers, water hyacinth, sudangrass, and sorghum.

8

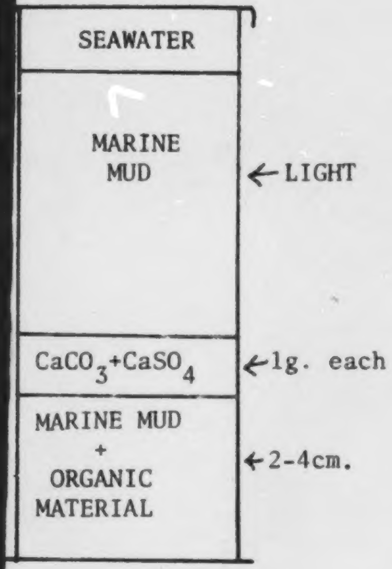
Combustion processes can also produce methanol by burning shredded trash with coal to heat water. This makes steam that generates electricity.

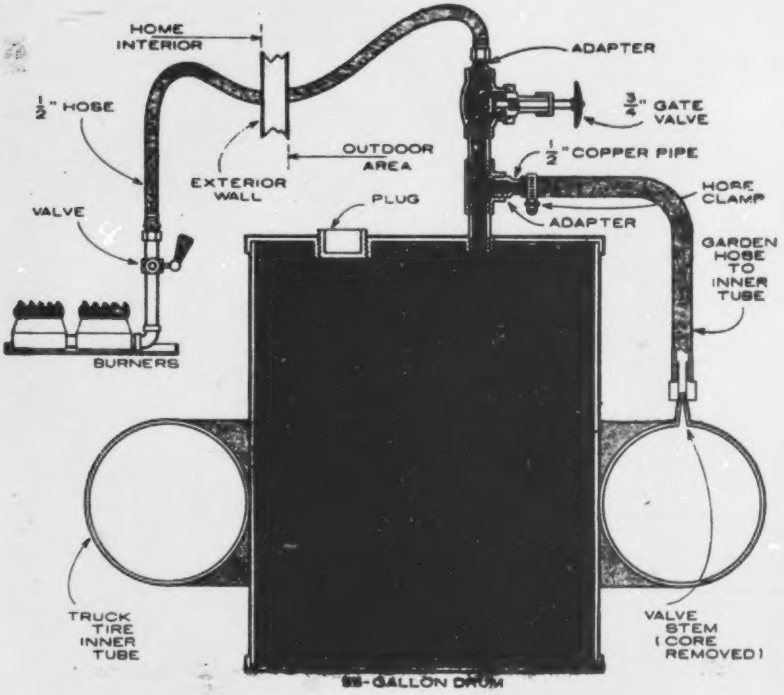
Biophotolysis, the fourth process, is the direct photosynthetic production of hydrogen. By direct photosynthesis, scientists hope to produce hydrogen for fuel. The hydrogen producers will then reproduce themselves or be useable as fertilizer or other valuable products. In one study at Texas A&M anaerobic (without oxygen) bacteria from marine and mud and bacterial cultures are being used to break down agricultural wastes such as chicken manure and cotton gin waste to produce hydrogen.

Hydrogen is expected to be an ecologically attractive, broadly useable, easily stored and transported fuel of the future. It is thought the anaerobic non-sulfur photosynthetic bacteria, Rhodospirillum rubrum, and the anaerobic sulfur photosynthetic bacterium, Chromatium vinosum, when grown in organic wasters can produce large amounts of low-cost hydrogen. In the Texas A&M study, marine mud was placed in a one-liter column with a 2-4 cm. layer of meat scraps and marine mud at the base, covered with 1 gram of $CaCO_3$ and $CaSO_4$, and topped with more marine mud and seawater (see figure XII-1). In the presence of light, good colonies of Chromatium vinosum developed in about 10 days. In the meantime, chicken manure and cotton gin waste were collected. Boiling water was poured over the waste, and the liquid was filtered with a vacuum pump. Once the colonies of Chromatium vinosum had developed, they were shifted to the filtered chicken and cotton-gin waste liquid.

Cultures of the Rhodospirillum rubrum were also added to other samples of liquid medium. These were placed in a warm water bath (30°C) under Tungsten light. The gas collected was measured by Warburg manometers. In the A&M experiment, it was found that when the bacteria is growing well,

406


SEAWATER
MARINE MUD
← LIGHT
$CaCO_3+CaSO_4$
←1g. each
MARINE MUD + ORGANIC MATERIAL
←2-4cm.


HOME INTERIOR
$\frac{1}{2}$" HOSE
VALVE
BURNERS
EXTERIOR WALL
OUTDOOR AREA
PLUG
ADAPTER
$\frac{3}{4}$" GATE VALVE
$\frac{1}{2}$" COPPER PIPE
HOSE CLAMP
ADAPTER
GARDEN HOSE TO INNER TUBE
TRUCK TIRE INNER TUBE
VALVE STEM (CORE REMOVED)
55-GALLON DRUM

DESIGN FOR A HOMEMADE MANURE-POWERED GENERATOR
(Popular Science, December 1975,p. 95)

Figure XII-1

water may be trapped behind dams as the tides come in, then used to turn water wheels and machinery as the tide goes out. One such tidal power plant was designed for Passamaquoddy, Maine. This is located on the Bay of Fundy on Canada's east coast where 50 foot tides occur. Another suggestion has been to install giant undersea windmill-like machines beneath the current of the Gulf Stream off the eastern coast of the United States. Electricity would be produced and transmitted by long cables to the mainland.

Plans are underway for anchoring floating power plants in the Gulf Stream and other ocean areas to vaporize fluids by exposing them to the warm temperatures of the upper layers of the oceans. The resulting steam-like vapors would turn turbine-generators, producing electricity. Suggested operating locations are at 200-foot depths.

Energy from Direct Conversion

Four new light, compact, and noiseless methods of producing electricity, which have the capability of using forms of energy such as radioactive waste, may be major sources of future power. The four types include fuel cells, thermionic tubes, MHD generators, and thermoelectric generators.

The fuel cell is a permanently charged storage battery in which gases such as hydrogen and oxygen go in one end and come out the other, changing chemical energy to electricity. (see figure XII-2)

Back in 1839, Sir William Grove, an English scientist, was able to make electricity by combining hydrogen and oxygen in a laboratory tank. Hydrogen enters the cell at the anode, reacts with the electrolyte and loses an electron. This positive hydrogen ion migrates toward the cathode while the free electron leaves the cell through the anode, passes through the external cirammonia inhibits the enzyme that produces hydrogen; when the bacteria ceases to grow well, it produces hydrogen.

The problems involved in setting up energy farms may include: competition for land with food and fiber crops, cost of conversion facilities, legal, political, and security problems inherent in ocean-based farms, and desalination of water for possible use of present nonarable land.

Energy from Waves and Tides

In wave power the problem is taming it. Ocean waves can pack a lot of power (applied energy). It is estimated that a single medium-sized wave breaking along a one-mile shore packs about 60,000 horsepower. Since many such waves break along the shore each and every minute, the power per hour is almost unbelievable. However, that enormous wave power is not being used to benefit people.

Many forces work together to make a normal ocean wave. The wave-making forces include rapid changes in atmospheric pressure, changes of the see floor, and wobbles in the earth's motions. Tidal action, the pull of the moon on the ocean surface, also helps to make waves. But the biggest wave-maker by far is the wind. We could use the wind-made waves for energy. One method involves building a pond along the top of a sloping seawall. Waves breaking over the seawall would fill the pond with water. Pipes running through the seawall would carry the water back to the sea. Turbines in the return path of the water would convert the energy of the rushing water into electricity.

Engineers have suggested using the rise and fall of tides to provide useable energy. When the difference between tides is at least 18 feet,

THE HYDROGEN-OXYGEN FUEL CELL

CELL REACTIONS:

$$H_2 \rightarrow 2H^+ + 2e^-$$

$$O_2 + 4e \rightarrow 2\,O^=$$

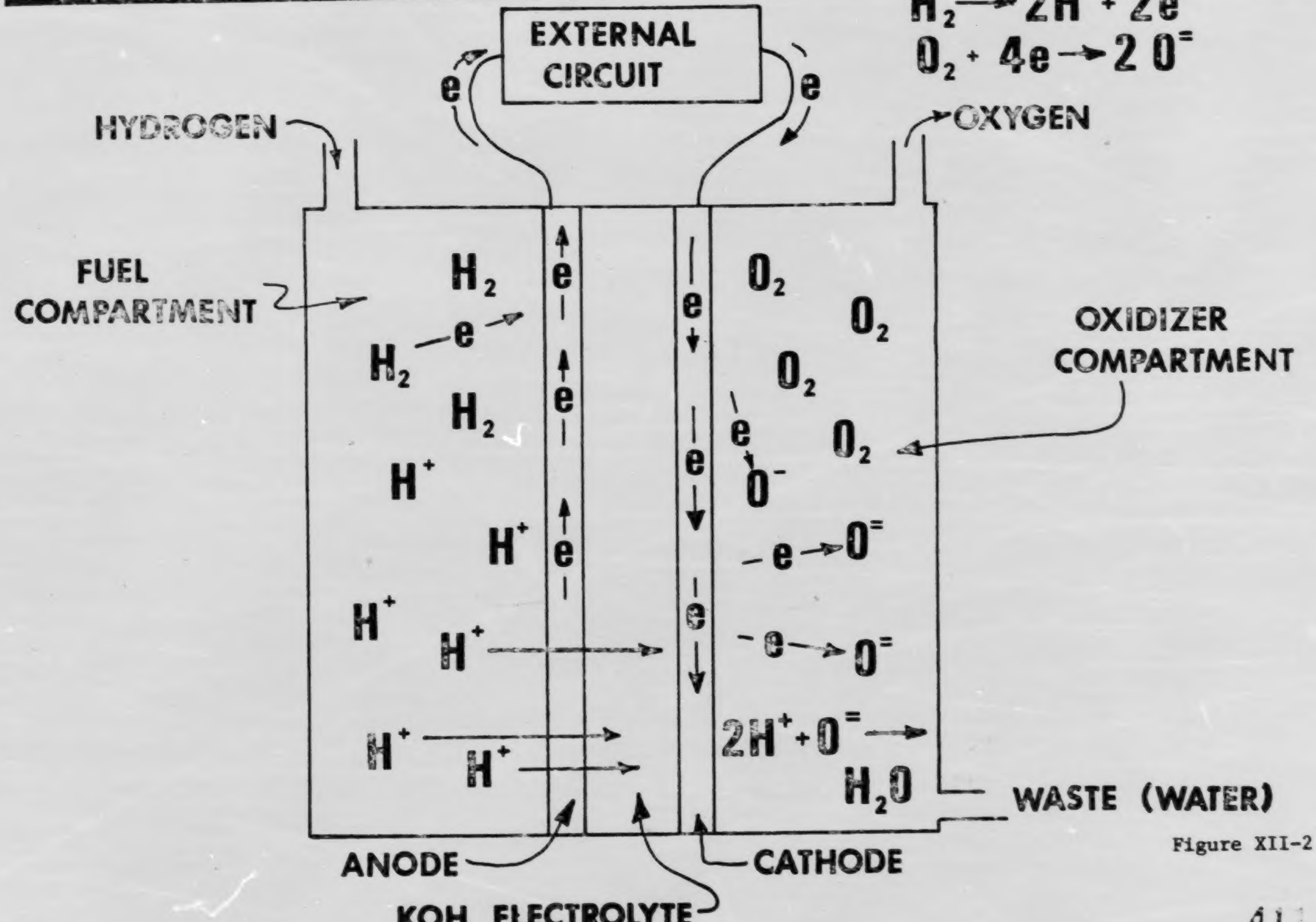

EXTERNAL CIRCUIT
e
e
HYDROGEN
OXYGEN
FUEL COMPARTMENT
H_2
H_2 — e
H_2
H^+
H^+
H^+
H^+
H^+
H^+
e
e
e
e
e
e
e
O_2
O_2
O_2
O_2
e O^-
e → $O^=$
e → $O^=$
$2H^+ + O^= \rightarrow$
H_2O
OXIDIZER COMPARTMENT
WASTE (WATER)
ANODE
CATHODE
KOH ELECTROLYTE

Figure XII-2

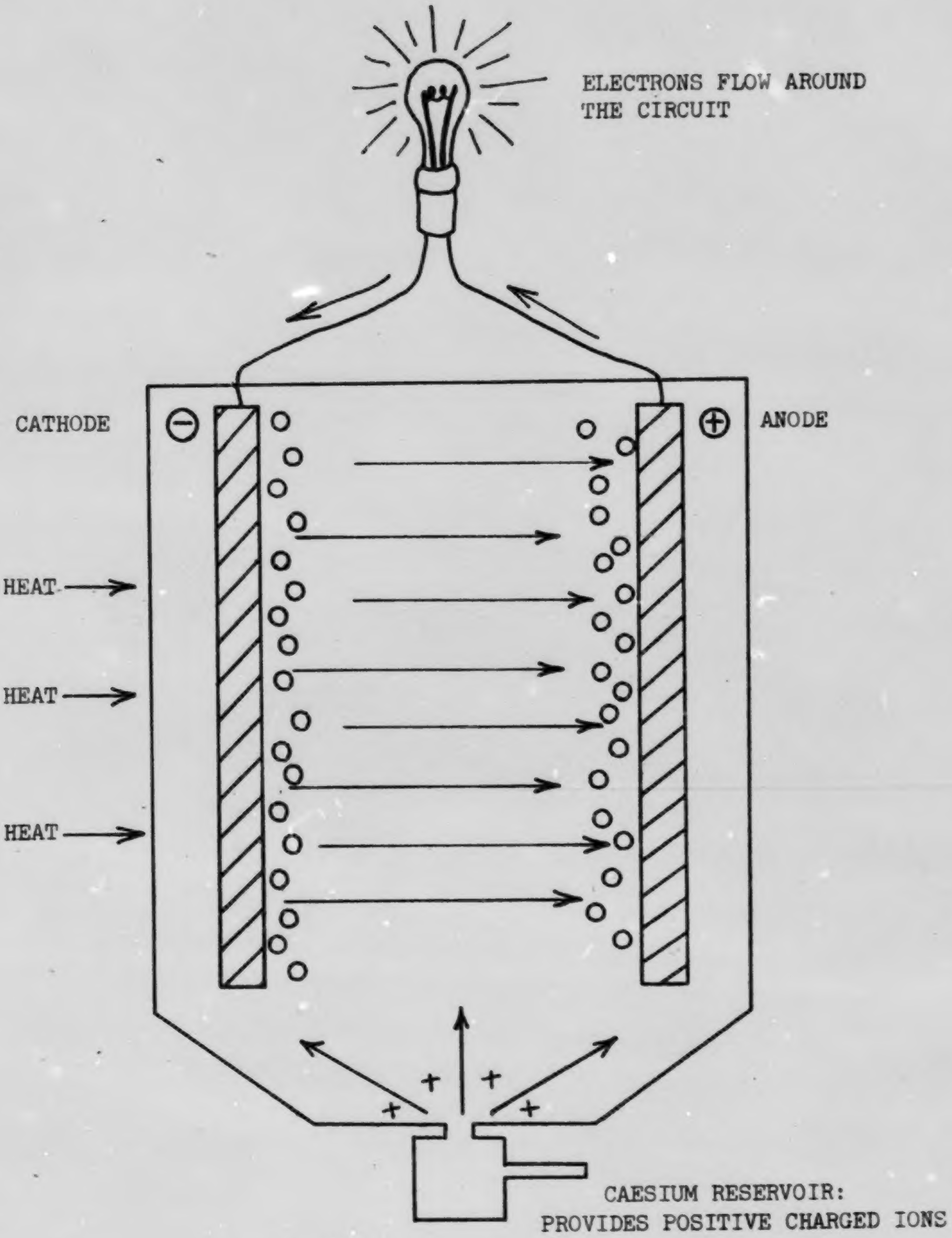
cuit and reenters the cell at the cathode. While this is going on, oxygen atoms are fed through the cathode, pick up electrons and combine with the hydrogen ions, which have travelled to the cathode. Fuel cells operate as slowed-down combustion reactors (slow motion burning). Water, carbon dioxide, and heat are the only waste products.

Fuel cells have been used in both the Gemini and Apollo spacecraft. At present, the cost of hydrogen production, using platinum electrodes, is prohibitive. If fuel cells can be developed for commercial use, they would be ideal for quiet smooth-riding cars. "You would fuel the car with cylinders of compressed gas. There would be two-pedal control--a brake and an accelerator which smoothly controls the output from the (fuel) cell..." (p. 58. Science Shapes Tomorrow.)

Thermionic tubes (also called thermionic generators or thermoelectron engines) change heat directly into electricity. A thermionic converter consists of 2 closely spaced metallic plates. "Boiled-off" electrons between the 2 plates form a cloud of negative charges. A gas containing positively charged particles fills the space between plates. These mix and neutralize the electron charge. This mixture of positive and negative particles is called PLASMA. Plasma makes a good conductor, letting emitted electrons move easily to the collector where they condense on the cooler surface. (see figure XII-3)

The key to the converter is to get more electrons boiled off the emitter than absorbed by the collector, providing a flow of electrons (current). Current uses have included light, efficient power plants which are used in nuclear reactors.

MHD generators convert heat directly to electricity. MHD is short


ELECTRONS FLOW AROUND
THE CIRCUIT
CATHODE
ANODE
HEAT
HEAT
HEAT
+
+
+
+
CAESIUM RESERVOIR:
PROVIDES POSITIVE CHARGED IONS

Leach, G. Science Shapes Tomorrow. John Day: N.Y. 1963, p. 62.

Figure XII-3

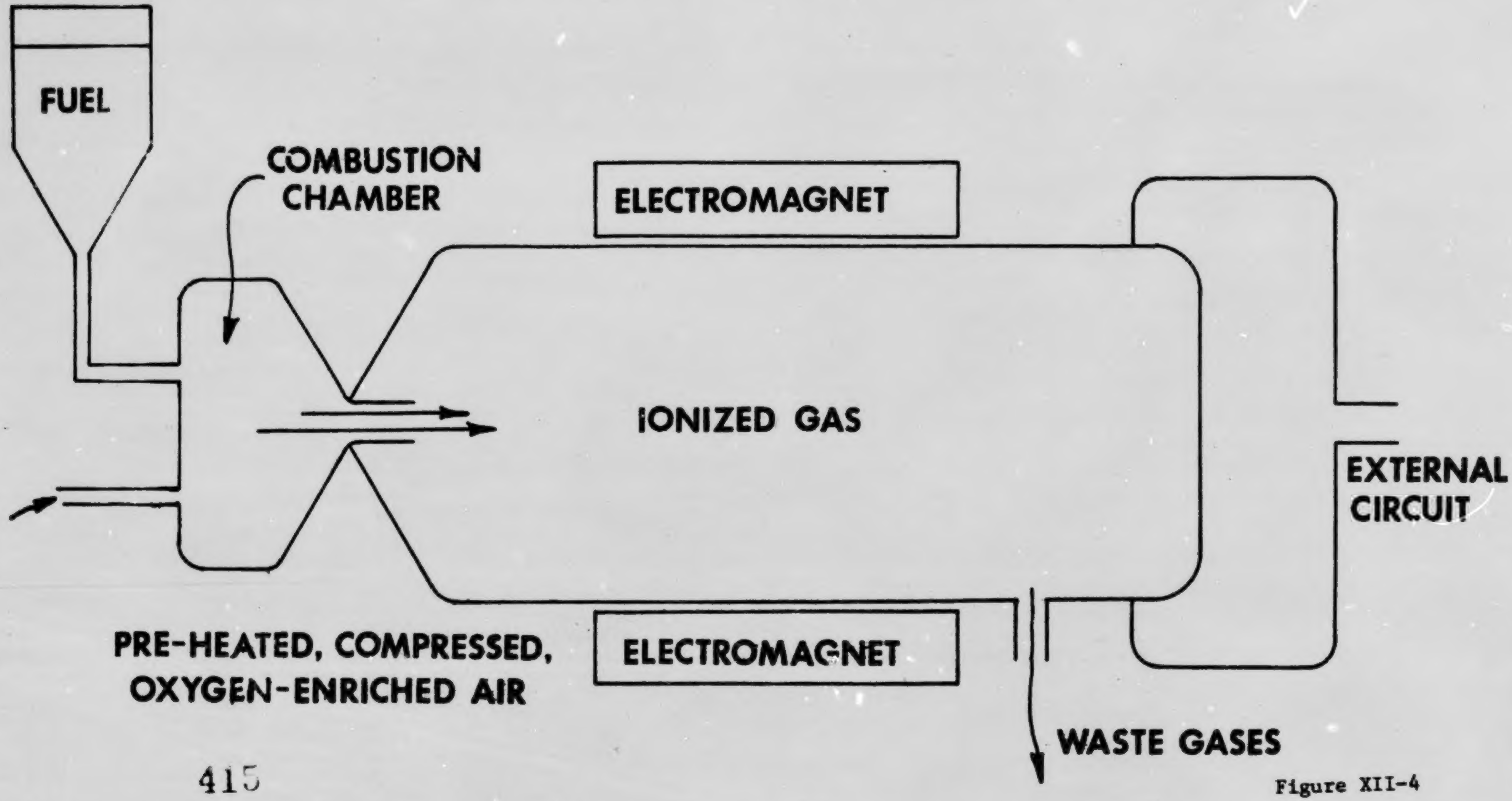
for magnetohydrodynamics. It is a way of making electricity by substituting an extremely hot ionized gas for the copper coils normally found in a generator. (see figure XII-4)

Powdered coal is burned in a combustion chamber in an atmosphere of preheated compressed air enriched with oxygen. The oxygen is seeded with millions of tiny particles to make it more conductive; this is squirted into the generating chamber at speeds greater than the speed of sound. At a temperature of 4000° to 5000° F the gas has lost a large portion of its electrons and has become ionized. As the ionized gas passes between the magnetic poles surrounding the generating chamber, the gas induces DC voltage between electrodes embedded in the chamber walls and a current is established in the connecting circuit. The principle was discovered years earlier when Michael Faraday found that an electric current would flow through a wire that has moved into a magnetic field.

Major problems include the serious corrosion of the duct, high temperatures, and providing a large magnetic field near high temperature gas. Advantages include no moving parts, size (a Mw unit would occupy an eight-foot cube), efficiency (70-80%), quiet, no pollution as wastes are carbon dioxide and water, and the exhausts are recycled to recover the seeding materials. Fans and pumps are the only moving parts.

Thermoelectric generators convert heat directly to electricity. The oldest direct conversion heat engine is the thermocouple. If you take two different materials with different metal cores, unite them, and heat the junction, a voltage can be measured. T. J. Seebeck, a German physicist, discovered this effect in his Berlin laboratory in 1821, but the idea was never used for power production until recently.

*MAGNETOHYDRODYNAMIC GENERATING SYSTEM



FUEL

COMBUSTION CHAMBER

ELECTROMAGNET

IONIZED GAS

EXTERNAL CIRCUIT

PRE-HEATED, COMPRESSED, OXYGEN-ENRICHED AIR

ELECTROMAGNET

WASTE GASES

Figure XII-4

Heating the hot junction drives the loose electrons toward the cold junction by the temperature difference. The larger the voltage, the greater the difference between a positive and negative terminal. The heat for these generators comes from long-lived radioactive isotopes. High temperature semiconductors for isotope operation require semiconductors that will withstand temperatures up to 2000° C. Low temperature semiconductors include silica and germanium. (see figure XII - 5)

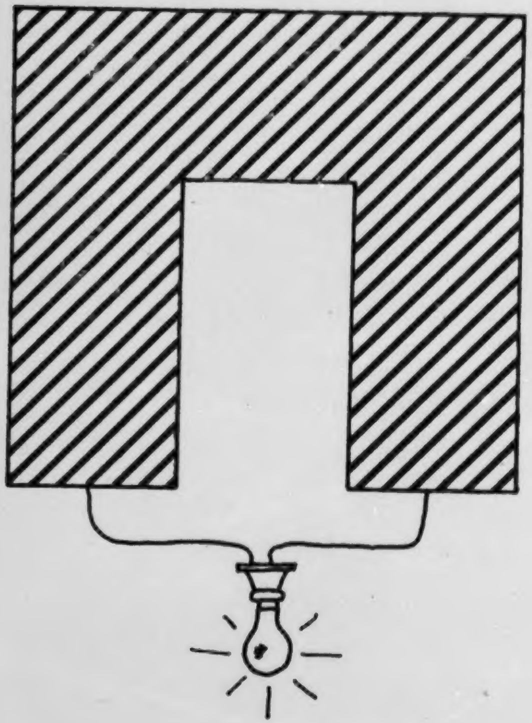
Thermoelectric generators may be used wherever on-the-spot generation is needed for electricity and where electricity needs to be produced for years without attention. These generators are used in satellites, underwater cables, polar areas, camping sites, and distant weather stations. Future uses may include refrigeration units which will be built into house walls so all one has to do is press a button to heat and cool the home.

Energy from Nuclear Fusion

The other major hope for the future seems to lie in nuclear fusion. Fusion is a form of nuclear energy resulting when gas of negatively charged electrons have separated from positively charged nuclei of atoms due to heat. These electrons and ions form a superheated gas called plasma. The ions often collide. The hotter they are, the harder they hit. If hot enough, the ions will combine or fuse to form new elements, releasing energy in the process.

In a nuclear fusion reactor, hydrogen gas will be enclosed in the core of a doughnut-shaped reactor. A very powerful electromagnet will surround the gas. When the magnet is turned on, the gas will be heated and squeezed together by the magnetic field. Hydrogen atoms in the gas

SEEBECK EFFECT


HEATED
COOLED
CURRENT FLOW

PELTIZER EFFECT

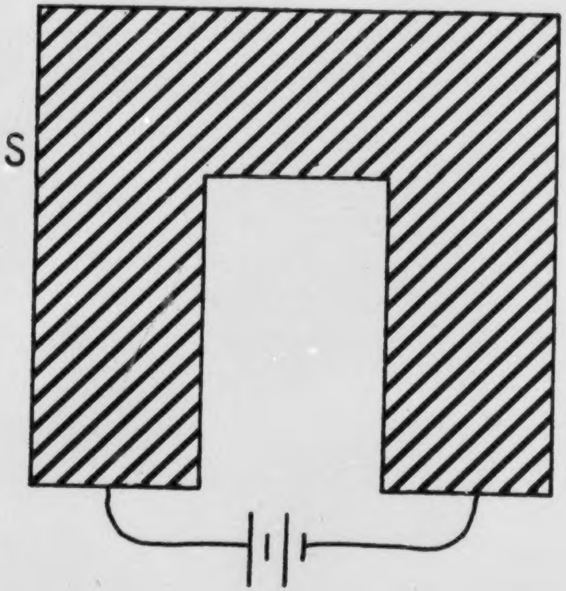

HEATS UP
COOLS DOWN
CURRENT FLOW

Figure XII-5

will collide with each other, fusing, and producing energy in the form of heat.

Liguid nitrogen or lithium in a heat-exchange system around the electromagnet will absorb the heat and transfer it to a steam generator for production of electricity. (see figure XII-6)

The major problem of the fusion reactor has been to generate, hold, and heat plasma in a suitable container to prevent it from hitting the sides of the container and losing energy. It was suggested that a strong magnetic field (magnetic bottle) would be the answer. Some scientists have also suggested a "fusion torch" using power from fusion reactors to break down solid waste into separable basic atoms.

Geothermal Energy

Volcanoes, boiling springs and geysers are types of geothermal energy. They've been around since time began, but not until 1905 has this type of energy been harnessed. It would be hard to harness an erupting volcano's energy, but research and exploration have brought about methods of harnessing geothermal energy that are feasible and less dangerous.

The primary method of tapping the geothermal energy is to drill wells into reservoirs of hot water or steam and allow the hot fluids to rise to the surface and be used to drive power generators. Because the well is a continuously erupting geyser, there are no pumping costs.

There are 2 types of geothermal fields: hot springs and deep reservoirs. Yellowstone National Park and Wairakei, New Zealand are examples of hot spring fields. Larderello, Italy and the Salton Sea area of California are examples of deep reservoirs. (see figure XII-7,8)

In 1905, Larderello, Italy became the world's first geothermal power

CONTROLLING the FUSION REACTION

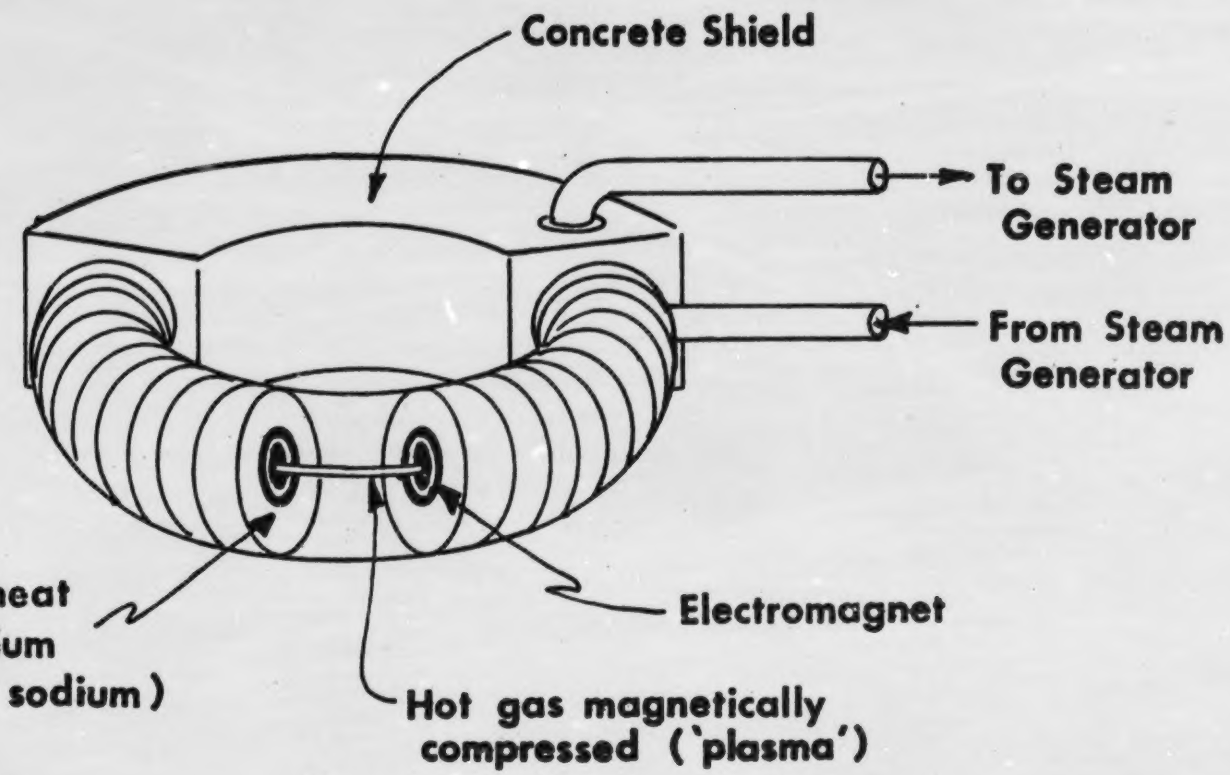

Concrete Shield
To Steam Generator
From Steam Generator
Pipe carrying heat exchange medium (such as liquid sodium)
Electromagnet
Hot gas magnetically compressed ('plasma')

Figure XII-6

HOT SPRINGS SYSTEM

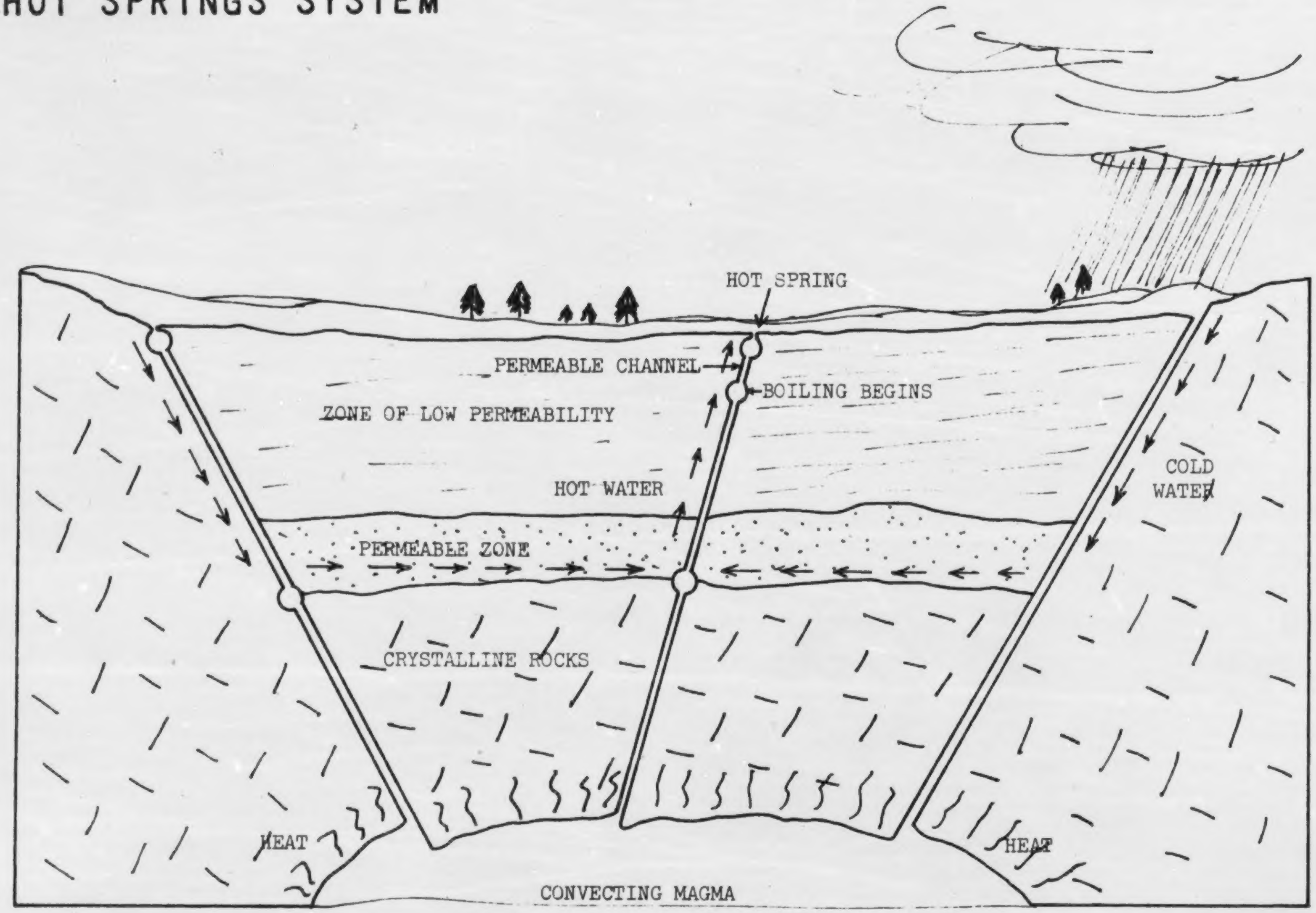

HOT SPRING
PERMEABLE CHANNEL
BOILING BEGINS
ZONE OF LOW PERMEABILITY
HOT WATER
COLD WATER
PERMEABLE ZONE
CRYSTALLINE ROCKS
HEAT
HEAT
CONVECTING MAGMA

Figure XII-7

INSULATED GEOTHERMAL RESERVOIR

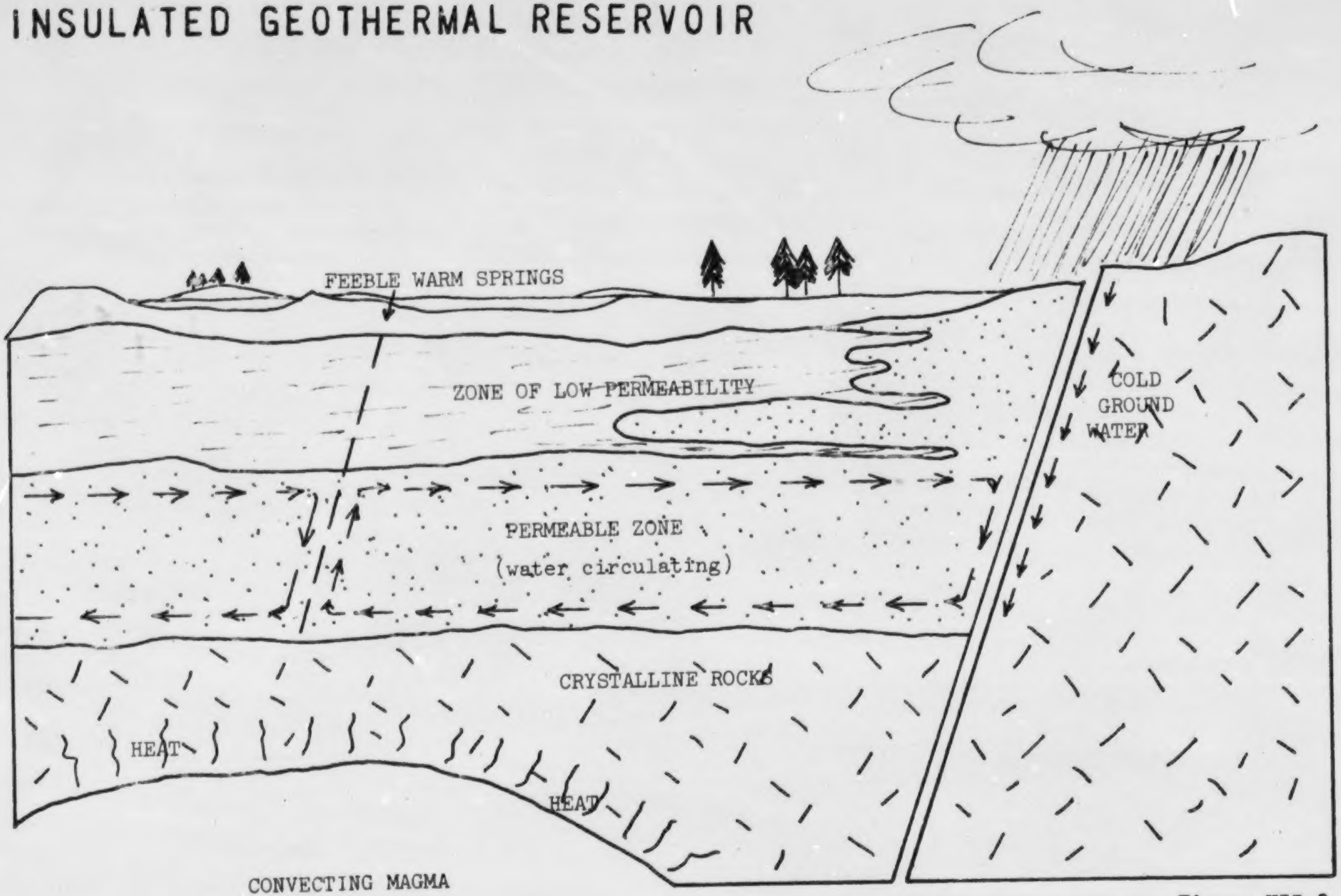

FEEBLE WARM SPRINGS
ZONE OF LOW PERMEABILITY
COLD GROUND WATER
PERMEABLE ZONE (water circulating)
CRYSTALLINE ROCKS
HEAT
HEAT
CONVECTING MAGMA

Figure XII-8

station. Then during the 1950's New Zealand began exploration of hot springs and geyser areas as potential sites for commercial steam. Today, the U.S., Japan and the U.S.S.R. are producing power from geothermal sources. Iceland uses hot water from geyser fluids for space heating.

The first U.S. geothermal commercial power plant was built in 1960 at "The Geysers," California. The plant capacity in 1967 was 54,000 kilowatts. By 1975, its capacity was 500 megawatts.

Energy Storage as a Secondary Source

As our electrically-oriented society continues to demand more electricity, the need for development of techniques for storing either the electricity or energy that can be converted to electricity becomes increasingly important. Improved storage methods are needed. Suggested methods include:

1. High temperature operation batteries (such as molten sodium and sulfur electrodes with a solid ceramic electrolyte, or a lithium sulfur cell with a molten electrolyte),
2. Pumped storage reservoirs to make present hydroelectric plants more economical,
3. Compressed air storage--in underground caverns, porous ground reservoirs, or depleted gas and oil fields,
4. Super flywheels with much greater storage capacity per pound than present lead-acid storage batteries,
5. Magnetic energy storage
6. Hydrogen storage, and
7. Thermal storage.

Problems arising from these will primarily be in required space and environmental damage or disturbance of wildlife.

ACTIVITIES

1. Create a collage of new and future energy technologies appearing in newspapers and magazines (Activity XII-1).
2. Construct a simple fuel cell (Activity XII-2).
3. View the slide presentation "The New Energy" (Activity XII-3).
4. Write a story on the future. Pretend you are now 75 years old and all the coal, oil, natural gas, and nuclear fuels have been used up. Is your life different? Have new discoveries been made or has society returned to using wood for fuel? Are there thousands of new convenience items, or are you living in caves and hunting with spears again? Write about a normal day of the future. Describe what has happened in the last 75 years (Activity XII-4).
5. Define the vocabulary words (Activity XII-5).

Making a Fuel Cell

(Activity XII-2)

When living things take in food and break it down for use in their tissues, energy is released--some in the form of electricity.

PURPOSE: To show how a biochemical fuel cell changes chemical energy to electrical energy.

PROCEDURE:

1. Dissolve yeast in water in the bowl.
2. Add enough flour to make some dough.
3. Let mixture stand at room temperature for about 3-4 hours until the dough rises. Is the yeast active at this point?
4. Stir some of the dough into the jar of water to make a thin paste.
5. Put a copper electrode and an aluminum electrode in the solution and connect the electrodes to a galvanometer. What voltage does the cell produce?

Can you connect enough cells together to light a flashlight bulb? How long do these fuel cells produce electricity?

(p. 106, Modern Science: Man, Matter & Energy)

Vocabulary

(Activity XII-5)

1. bacteria-

2. biophotolysis-

3. combustion-

4. fermentation-

5. fuel cells-

6. MHD generators-

7. methane-

8. organic waste-

9. pyrolitic-

10. thermionic tubes-

11. thermoelectric generators-

12. thermocouple-

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide an overview of possible energy sources, other than solar, nuclear, and wind power. Students will need to read and discuss the information section before beginning activities. This chapter is only introductory; more information can be found on each of the topics presented here.

To make students more aware of the media and the public's attitude about energy and conservation, they should delve into newspapers, magazines, booklets, periodicals; anything that discusses or illustrates a new or unusual energy technology. All the articles and pictures can be displayed on a collage.

A simple fuel cell can be constructed in Activity XII-2 for the more scientific-oriented. The slide presentation and the story bring out opinions and attitudes and they promote futuristic thinking. The vocabulary words may be helpful in fostering comprehension.

List of Materials

Activity XII-1

articles and pictures from newpapers, booklets, periodicals and magazines

posterboard or display area

glue

scissors

Activity XII-2

5 gm. yeast

500 milliliters lukewarm water

enough flour to make a dough

bowl

pint or half-pint jar of water

galvanometer

copper electrode

aluminum electrode

Activity XII-3

slide presentation

slide script

slide projector

Activity XII-4

pencil or pen

paper

Activity XII-5

vocabulary list in hand-out form

pen or pencil

Test

1. Energy farming is:

   * A. producing energy from organic waste.

   B. growing uranium plants.

   C. building power plants in rows like a field.

   D. producing energy from gas and oil.

2. Organic waste digesters:

   A. produce petroleum by fermentation.

   B. produce propane by photosynthesis.

   * C. produce methane gas by fermentation.

   D. produce ice cream by pasturization.

3. Thermochemical processes produce:

   A. ethanol.

   * B. methanol.

   C. propanol.

   D. alcohol

4. The major problem with using wave power is:

   * A. its hard to tame.

   B. it costs too much.

   C. its not feasible.

   D. its not dependable.

5. Tidal action is caused by:

   A. changes of the sea floor.

   B. wobbles in the earth's motion.

   C. rapid atmospheric changes

   * D. pull of the moon.

6. By burning shredded trash w/coal to heat water, the combustion process produces:

   A. ethanol.

   * B. methanol.

   C. propanol.

   D. alcohol.

7. An example of a tidal power plant is located at:

   * A. Passamaquoddy, Maine

   B. Lagos, Nigeria

   C. Glamorgan, South Wales

   D. Mbabane, Switzerland

8. Fuel cells powering have been used most recently for:

   A. watches.

   B. flashlights.

   * C. spacecraft.

   D. cars.

9. MHD generators convert heat directly to:

   A. light.

   * B. electricity.

   C. hydrogen.

   D. power.

10. Thermoelectric generators convert heat directly to:

    A. light.

    * B. electricity.

    C. hydrogen.

    D. power.

11. Nuclear fusion uses magnets to:

    A. split a hydrogen atom.
  * B. combine hydrogen atoms.
    C. weld metals.
    D. cause confusion.

12. Nuclear fusion produces directly:

  * A. heat.
    B. electricity.
    C. methanol.
    D. steam.

13. A volcano is a natural form of:

    A. geonuclear energy.
    B. combustible energy.
    C. thermoelectrical energy.
  * D. geothermal energy.

14. The first U.S. geothermal commercial power plant is located at:

    A. Lardello, North Carolina.
    B. Yellowstone, Wyoming.
  * C. "The Geysers", California.
    D. Salton Sea, California

The New Energy

(Slide Presentation: Activity XII-3)

Slide	Narration
1. ENCORE	
2. Title:	Our energy sources are running out. This slide presentation will explore "The New Energy: the kind that does not just happen."
3. Powerlines	Electrical energy is produced in many different ways. The supply of fossil fuels used in producing electricity will not last past the year 2000 unless we conserve. For this reason new and unusual energy sources are being explored.
4. Hydrogen-producing bacteria	The Plant Science Department at Texas A&M University is looking into hydrogen-producing bacteria.
5. Marine-mud bacteria	This is bacteria being produced from marine mud. In a one liter column container, marine mud and organic materical are placed on the bottom layer, one gram each of $CaCO_3$ and $CaSO_4$ makes up the second layer, more marine mud and seawater are placed on top. A culture column like this will make hydrogen-producing bacteria.
6. Liquid waste in flasks	Liquid wastes can also form hydrogen-producing bacteria.
7. Hydrogen-producing bacteria in water bath	This is bacteria being formed in a water bath.
8. Warburg manometers	Hydrogen gas production is measured by these Warburg manometers.

9.	Cow	An original methane producer, the cow. The Veterinary Microbiology Department at Texas A&M is isolating methane-producing bacteria for breakdown of feed lot and hog lot wastes. The wastes produce methane gas that can be used for on-site electricity at the farm where it is found.
10.	Ranch	Ten cows burp enough gas in one year to provide all the space-heating, water heating, and cooling that a small house needs.
11.	Man on a front-end loader	Cows and other livestock provide the solid waste for methane production.
12.	Airplane	Wind power is a source of energy. Windmill designs developed through the interest in the aerodynamic principles of airplane propellers.
13.	3-bladed vertical-axis windmill	An international student competition was held in Albuquerque, New Mexico. Students from the Massachusetts Institute of Technology submitted this 3-bladed, vertical-axis windmill. The design utilized an unusual pitch of the blades that keeps the power efficiency constant as the speed of the blades are reduced.
14.	Conical wind devices	Students from North Carolina State invented a vertical axis windmill that can operate at very low winds with very low drag.
15.	Foil-shaped rotor windmill	This bizarre savonius type windmill uses shroud to channel wind to foil-shaped rotors. It rotates at varying wind speeds.
16.	Wave	Water power is used as an energy source. Water turbines, pumped storage, and tapped temperature differences or currents within the sea are all being considered if not in use already. The rise and fall of tides provide useable energy but tides of this kind are found only in a few ares of the world.

17. Fuel cell tractor	This is a tractor designed and built in the early 1960's and powered by fuel cells. It is too expensive to be practical.
18. Thermionic generator	A thermionic generator changes heat directly into electricity, Thomas Edison, in 1883, discovered the "boiling off" of electrons from a hot metal surface. By raising the temperature of the metal, electrons gain such high speeds that they escape the metal surface. This is the principle behind the thermionic generator. They are used in power plants and nuclear reactors.
19. MHD generator	The MHD generator converts heat directly to electricity. MHD is short for magnetohydrodynamics. It is a way of making electricity by substituting an extremely hot ionized gas for the copper coils normally found in a generator.
20. Buoy	This buoy is lighted by thermoelectric power. Thermoelectric generators can be used where electricity needs to go for years without attention.
21. Underwater cable	Underwater cables, polar areas, camping sites and distant weather stations.
22. Vacuum flask	Superconductivity is demonstrated in this slide.
23. Solar collector	Solar energy is stored in collectors like this one being developed by Mechanical Engineering students at Texas A&M.
24. Solar collector	The University of California at Berkeley built these flat-plate collectors. They use a double row of flourescent tubes for cover and are much cheaper than plate glass.
25. Solar power tower	Scientists are thinking of many ways to store and use solar energy. This solar power tower would use thousands of mirrors to generate electricity.

26.	Solar heated go-cart	The University of Oklahoma developed a go-cart that can get 30 miles per hour from its solar-heated engine. It utilizes thin silver mirrors with fiberglass backing on parabolic suntracking reflector.
27.	Solar engine	Designs for solar energy operated engines are possible in the future.
28.	4 strokes of solar engine	Solar engines may have four cycles like gasoline engines.
29.	Solar balloons	These balloons are filled with solar heat. The black triangular-shaped balloon is named the Solar Firefly.
30.	Solar satellite station	Solar energy possibilities are limitless. This is a model showing a solar satellite station sending energy to earth.
31.	Nuclear fusion reactor	Fusion is a form of nuclear energy. This is an experimental fusion reactor at the U.S. Energy Research and Development Administration, Los Alamos Scientific Laboratory in New Mexico.
32.	Underground power station	Gouged out of the granite heart of Northfield Mountain in Massachusetts, this giant hall will be the power-house of the nation's largest pump storage installation. Longer than a football field and 10 stories high, it will contain four reversible pump-generators capable of lifting 5 billion gallons of water to a mountain top reservoir and generating a million kilowatts of power as the water runs down.
33.	The "New Energy: the kind that doesn't just happen"	There are many more unusual energy sources being explored by scientists and technicians. These are just a few. In developing new technologies "the indispensable energy resources are the human intellect, creative curiousity....and wisdom."
34.	The End.	

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Slides: "Our Energy Problems," 22 color slides & script.
(energy crisis, where energy comes from, alternatives)

Visual Masters Set: "Energy Resources: Past, Present & Future". Script with introduction, av. ½ pg. script per transparency, includes suggested questions. MINIMAL CHARGE FOR SLIDES & TRANSPARENCIES.

Chart

Energy History of the United States, 1776-1976. ERDA. With "So What's New" user's manual. ERDA Office of Public Affairs, Washington, D. C. 20545.

Film and Filmstrips

"Did Indians Have Machines?" 13 min. SRA. ($106) FS and record.

Texas Power & Light (Free Loan):
"Oceans of Power." 20 min. color. Research in nuclear fusion reaction and projects sponsored by the Texas Atomic Energy Research Foundation.

"Energy: Critical Choices Ahead." 27 min. color. Graphically analyzes the magnitude of our energy problem.

Kerr-McGee Corp. (Free Loan through Modern Talking Pictures)
"The Leading Edge." Future fuel search while intelligently using present resources. #4411.

Caterpillar Tractor Co. (Free Loan through Modern Talking Pictures)
"Struggle in Power." 28 min. color. How coal can do the most to solve the energy crunch. #30273.

Edison Electric Institute (Free Loan through Modern Talking Pictures)
"A Question of Balance." 28 min. color. Present and future challenges to meet electricity needs.

ERDA Film Library, Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee (Free Loan)
#0488--"To Bottle the Sun" 5½ min. color.
#0507--"Energy--The American Experience" (Past 200 years) 28½ min. color.
#0508--"Challenge of the Future" (Look beyond 2000 A. D.) 29 min. color.
#0358--"Superconducting Magnets" 12½ min. color.
#0484--"A Superconducting Magnet for Fusion Research" 22 min. color.

National Geographic Society, Dept. 1037, Washington, D. C. 20036
Filmstrips and cassettes. "Energy for the Future." Last of a series of 5 energy subjects. Color. $67.50/set.

McGraw-Hill Film, 1221 Avenue of the Americas, New York, NY 10020
Free loan. "Energy Sources of the Future." 15 min. color.

ENCORE

Chapter 13

Energy Conservation Resources For Education
Department of Industrial Education, Texas A&M University
College Station, Texas 77843

OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. make compost for fertilizer.
2. explain orally or in writing the function of a greenhouse.
3. use natural control methods that favor beneficial insects and discourage pests.
4. select crops that facilitate high yields in a limited amount of space.
5. grow his own garden.
6. define a list of vocabulary words related to growing a garden.

GROW YOUR OWN GARDEN

Energy can be conserved in many ways. One not-so-obvious way is by growing your own garden. Fossil fuels are used to plant, grow, harvest, and transport food. Also, left-overs and garbage use up energy when they have to be transported and disposed of. If Americans could learn a few simple gardening methods to grow our own food, we could become almost self-sufficient. It has been done before: in the depression of the thirties money and gasoline were scarce, so many thousands of people started producing their own food. During and after World War II, Americans made "victory gardens" to help alleviate the food shortage. But through the growing economic wealth of the 50's and 60's, Americans grew accustomed to the times of plenty, and we have wasted food and the energy required to produce it. Now, Americans need to realize that because of wastefulness, we are experiencing an energy crisis. We can grow much of our own food, and we can use the wastes from our homes and yards by learning a few facts about gardening and by following local expert's advice. Some of the following suggestions vary from place to place. Be sure to get some advice from an experienced farmer, county agent or member of a garden club.

A garden can be grown any place that has enough nutrients and sunlight--backyards, greenhouses, apartment roofs, boxes or pots. A new garden will mature over a period of years and balance nutrients naturally. With the proper care your garden will flourish.

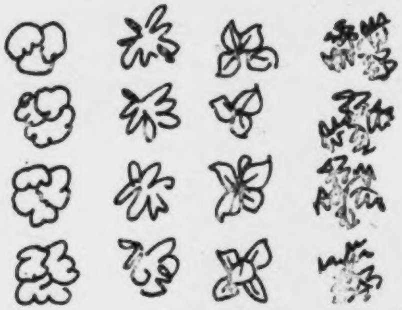
When choosing the area for your garden, pick an area that gets lots of sunlight, has good drainage and is protected from the wind. Theoretically, more vegetables will grow in a small area with ideal conditions than in a large area with poor conditions. It should have at least six hours of sunlight each day. The shape of your garden does not matter; use any sunny place that is available.

Plants can be spaced close together, but if plants are spaced too close it may cause rapid spread of infection or wilting. If your sunniest spot is on a patio or breezeway, plant crops in boxes or barrels. If this crowds the plants, be sure to use good soil, and do not neglect watering and fertilizing. If you have a shaded area unsuitable for tomatoes or root vegetables, plant leafy vegetables such as lettuce, chard, mustard and endive.

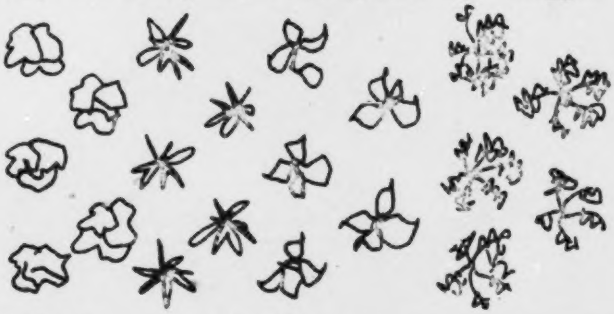
Prepare your garden bed by digging deep. If you strike a layer of hard clay or rock-filled soil a few inches below the surface, break it up to a depth of at least a foot. If soil is shallow with a layer of hard rock just below the surface, build a frame on the ground and fill in with good soil. If your garden bed is not deep enough, you will produce spindly crops because the plants will be forced to grow near the surface instead of sinking deep healthy roots.

Plan your garden on paper, and use space wisely. Do not overplant; two parsley or chive plants, for example, will produce all that an average family needs. Avoid "space-hogging" vegetables. If space is tight, you can plant six rows of carrots, beets, or onions in the space as one row of squash. With some crops, peas and spinach, for example, the harvest will last only a few weeks. You may want to favor those vegetables--tomatoes, broccoli, kale, lima beans, squash, okra, eggplant, peppers, chard, crowder peas and brussel sprouts--which keep producing until the first frost hits.

The physical arrangement of the plants should not be placed in military alignment.



It is best to copy the honey bee's honeycomb and stagger the rows:



This allows for closer rows while keeping distance between individual plants. To save space, use vine-type vegetables when you can and give them a stake, fence, or other support to climb on. The support should extend four or five feet above ground. As the plant grows, tie the plant to the stake with cloth strips because string can cut into the stems. Be sure to plan ahead, so the high growing plants will not shade the lower plants.

Follow the directions on the seed packet so you will not plant seeds too shallow or too deep. A rule of thumb: plant no deeper than three times the thickness of the seed.

A garden needs about an inch of water a week. The most effective and least wasteful method of watering is with a trickle system. An example is a porous hose or perforated plastic pipe that releases a slow, steady flow of moisture into the ground. Less water is lost by evaporation with this method than with sprinkling, and your garden gets a deeper watering each time.

A good garden must be worked continuously to keep unwanted weeds out and to keep the soil loose. Weeds take nutrients that are beneficial to the plant from the soil. If the ground is left to sit, it becomes hard and less porous. Loosening the soil helps the soil absorb water.

Pest Management

Pesticides are poisons that kill pests including insects, weeds, and plant diseases. After a generation of use, pesticides have produced and are still producing serious side effects to public health, wildlife, soil, and balanced natural ecosystems. There are two alternatives in the use of pesticides: (1) the use of safe pesticides in a controlled way and (2) the use of techniques that do not use any pesticides at all.

There are many alternative ways of controlling pests. Some of them are bait, light traps, resistant crop varieties and "soft" pesticides. A more permanent method is based on encouraging the natural enemies of pests, predators, parasites and diseases. In other words, control pests biologically rather than chemically. Another natural enemy of garden pests is birds. A bird feeder, bird bath or a pine cone soaked in suet can attract the birds' attentions. You can also control insects merely by picking them off and killing them or their egg clusters. One of the most effective bug controls is simply a jet of plain water.

Crop patterns and local environments can be modified to favor beneficial insects already in the field, or they can discourage the presence of pests. Flowers provide food for helpful adult insects. Helpful creatures include earthworms, bugs that eat bugs, lacewings, mantises, wasps, and lady bugs. Some plants attract pests and can be used in the general area to lure unwanted pests away from the main garden.

If disease is present or if insect invasion is serious, see your garden store owner immediately for the best controls. Take along samples of the insects and affected plants in sealed bottles for your garden store owner to inspect.

Soil Fertilizer

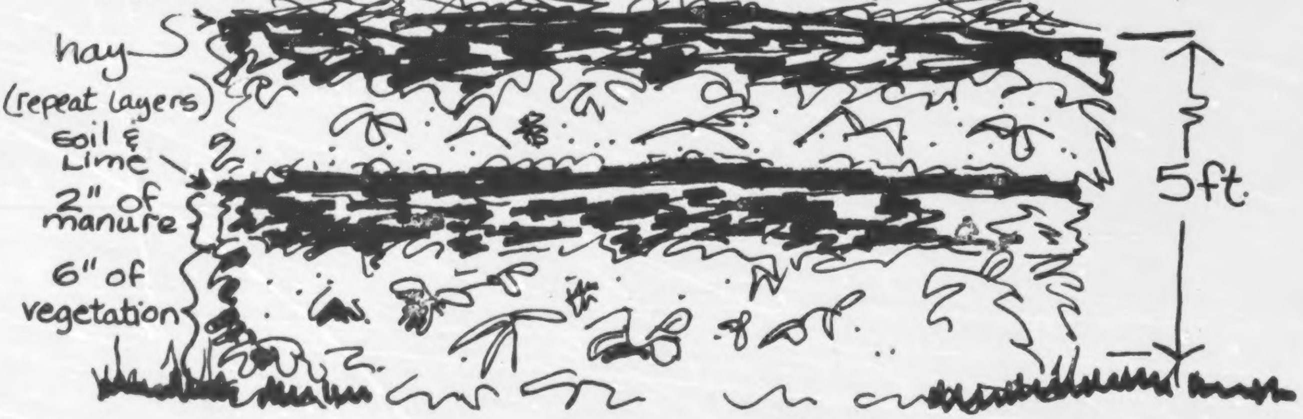
To give ample nourishment to your crops some type of fertilizer should be used. Fertilizers contain three main elements: nitrogen, phosphorus and potassium. Different fertilizers contain different percentages of these three elements. Some common store-bought fertilizers have 12%/24%/12%, 30%/10%/10%, 15%/30%/15%, or 13%/13%/13% for each element respectively. Generally, a garden needs a fertilizer with a higher nitrogen percent. The remaining elements in fertilizer are secondary materials such as calcium, magnesium and sulfur.

The formation of humus is the most important component of soil fertilizer. Humus can be made by gathering up organic wastes and letting the materials decay in a "compost pile". By putting the pile together carefully and with attention to detail, a rich fertilizer and soil conditioner can be produced.

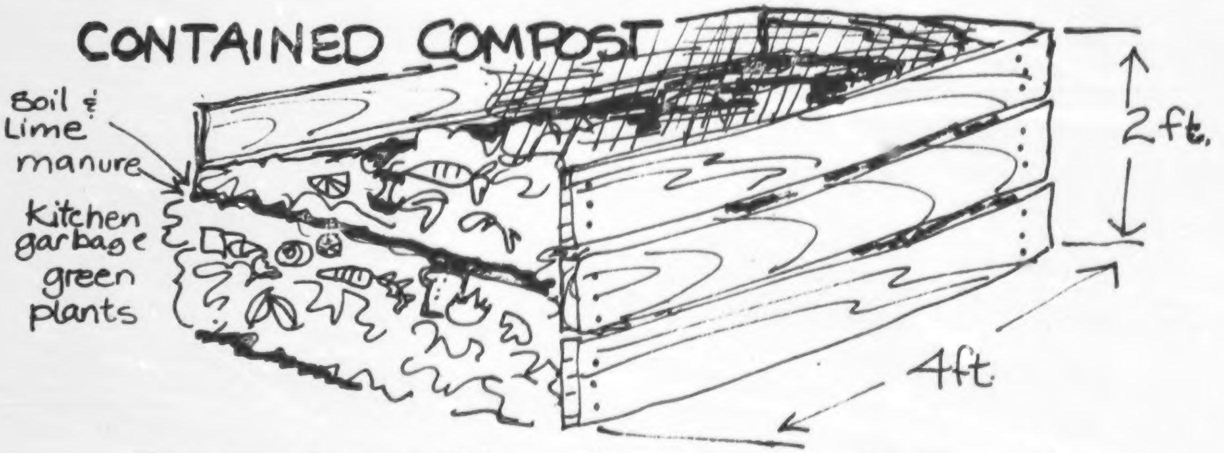
Most compost piles are made in three layers. These layers are stacked to form a large compost pile. The first layer consists of vegetation. The second layer is barnyard manure and the third layer is a soil layer (with a sprinkling of lime, if needed). Two good methods of preparing compost are the Howard method and the contained method.

The English scientist, Sir Albert Howard, through much experimentation, came up with an excellent compost. The Howard method of building a compost is to first clean a spot on the ground and stack six inches of as many different kinds of vegetation as possible. The next layer is two inches of barnyard manure unless the manure is from poultry where an inch is sufficient. The next layer is a soil layer and should have a sprinkling of agricultural lime to control acidity and any other minerals desired, including 1/4 to 1 inch of nitrates. The length of the compost does not matter but the width should be six to seven feet so that it will not dry out (when it is too narrow) or does not receive sufficient air (when it is too wide). Both the vegetation layer and the manure layer should be thoroughly soaked immediately after being laid. The stack should be built approximately five feet in height and left alone. Top the stack off with hay, leaving the top concave to catch rain. After three weeks turn the stack completely, the outside going to the center. Do not give up; hold your breath and you will get used to the smell eventually. Five or six weeks after the first turning of the stack, it is turned a second time. A month later the compost is ready for use or storage. The Howard compost takes three months to mature.

HOWARD COMPOST METHOD



A box or barrel can be used to make another kind of compost. A common size is four feet in length, two feet in width, and four feet in height but available space and preference should decide the size. Half inch cracks should be left for air circulation. The first layer should be green plants; the second, kitchen garbage (practically everything except tin cans and glass); the third, a thin layer of barnyard manure, if available, and the fourth, ½" of soil with lime mixed in it. If you use leaves, a light sprinkling of some nitrate fertilizer will hasten the disintegration of the leaves. Continue the layers until the box is about full. Be sure to wet the vegetation, garbage, and manure. A top layer of dirt, fairly thick, should be used. Cover the box with wire mesh to keep out animals.

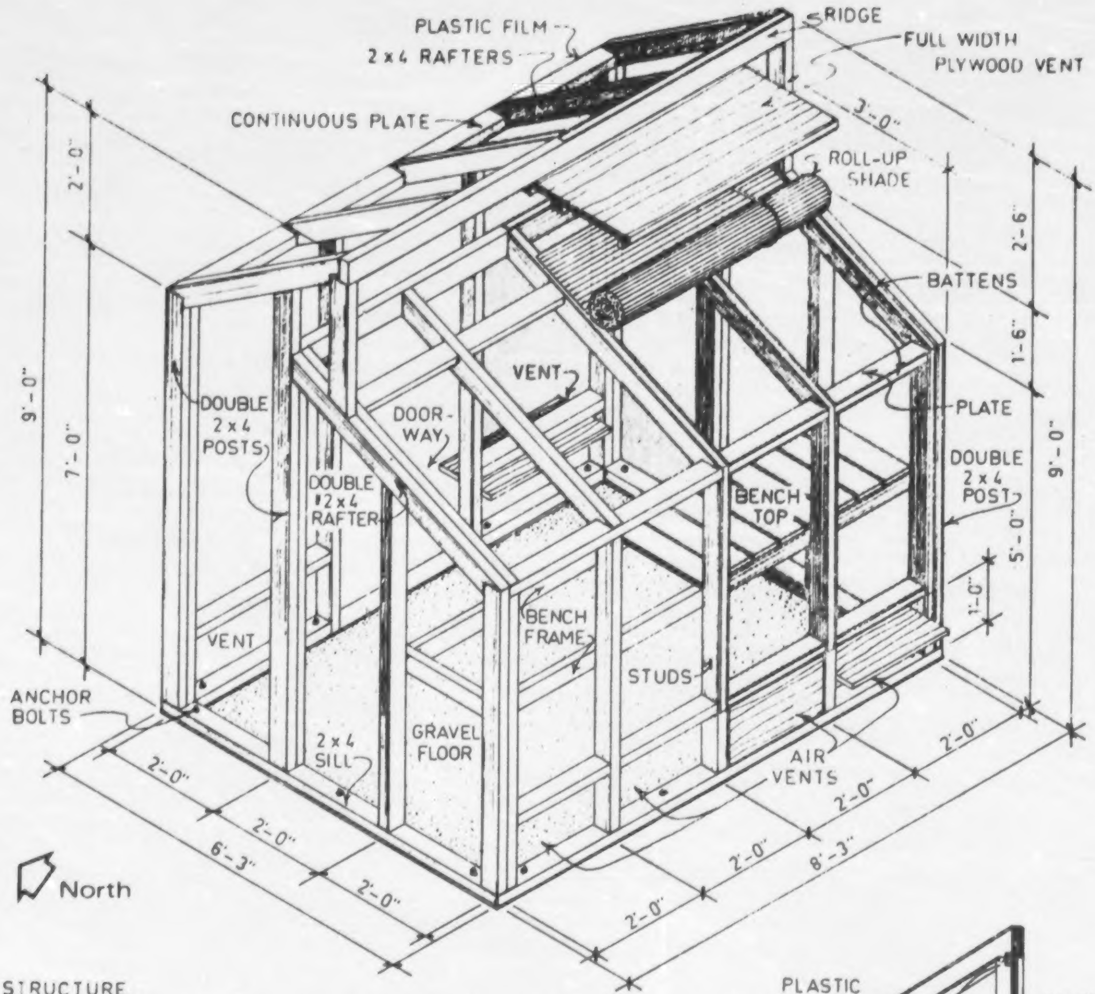


These are only two methods used to make compost. Drums can be bought through magazines in which compost can be built, or composts can be made in plastic bags if space and time are limited.

The Greenhouse

A greenhouse is a glass or plastic-covered building where temperature and humidity can be controlled. There are many greenhouse designs and furnishings that are easy and inexpensive to build.

LOW COST GREENHOUSE


PLASTIC FILM
2 x 4 RAFTERS
RIDGE
FULL WIDTH PLYWOOD VENT
CONTINUOUS PLATE
3'-0"
ROLL-UP SHADE
2'-0"
2'-6"
BATTENS
1'-6"
7'-0"
9'-0"
VENT
PLATE
DOUBLE 2 x 4 POSTS
DOOR-WAY
DOUBLE 2 x 4 POST
DOUBLE #2 x 4 RAFTER
BENCH TOP
9'-0"
5'-0"
1'-0"
BENCH FRAME
VENT
STUDS
ANCHOR BOLTS
2 x 4 SILL
GRAVEL FLOOR
AIR VENTS
2'-0"
2'-0"
2'-0"
2'-0"
6'-3"
2'-0"
2'-0"
2'-0"
2'-0"
8'-3"
North

STRUCTURE
WATERPROOFED DOUGLAS FIR OR REDWOOD, CONSTRUCTION GRADE 2 x 4's, 300 LIN. FT.

SKIN
HEAVY OR MEDIUM WEIGHT CLEAR, SUN-RESISTANT VINYL OR POLYETHYLENE FILM 8' WIDE BY 30' LONG

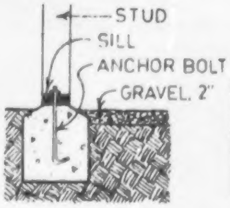
BATTENS
REDWOOD LATH, 1/4" x 1 1/2", 240 LIN. FT.

VENT DOORS
CUT FROM 1 SHEET OF 1/2" THICK x 4' x 8' EXTERIOR GRADE PLYWOOD

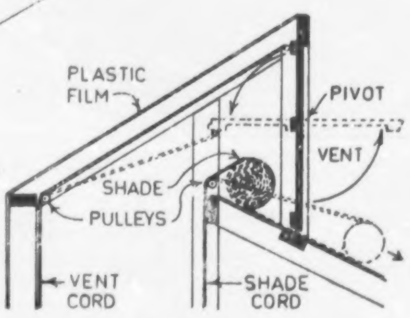
DOOR
2'-6" x 6'-8" SALVAGED STORM OR STANDARD EXTERIOR DOOR

FOOTING & FLOOR
APPROXIMATELY 18 CUBIC FT CONCRETE, 14 ANCHOR BOLTS. & 8 CUBIC FT GRAVEL FOR 2" THICK FLOOR

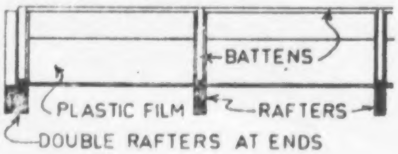
SHADE
BAMBOO OR PLASTIC ROLL-UP SCREEN 8' WIDE x 8' LONG


STUD
SILL
ANCHOR BOLT
GRAVEL. 2"

Footing


PLASTIC FILM
PIVOT
VENT
SHADE
PULLEYS
VENT CORD
SHADE CORD

Vent & Shade

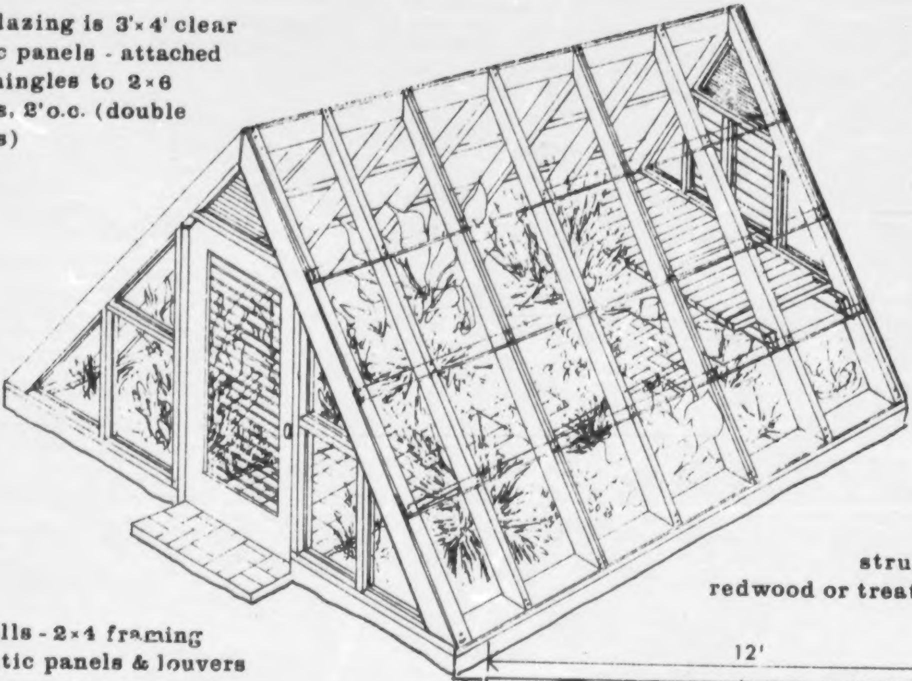

BATTENS
PLASTIC FILM
RAFTERS
DOUBLE RAFTERS AT ENDS

Rafters & Skin

Homemade Greenhouse by Jack Kramer
Design by Adrian Martinez

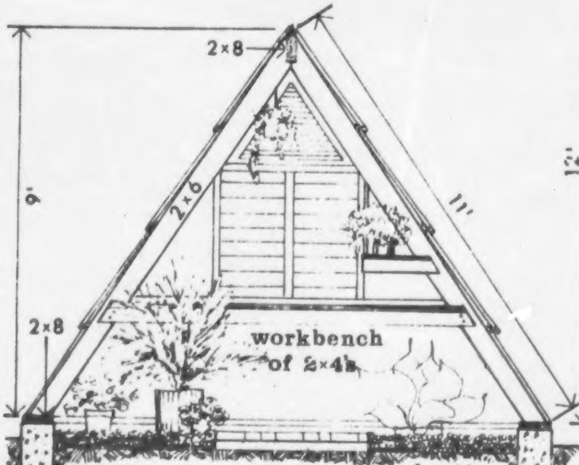
A-FRAME GREENHOUSE

roof glazing is 3'×4' clear plastic panels - attached like shingles to 2×6 rafters, 2'o.c. (double at ends)

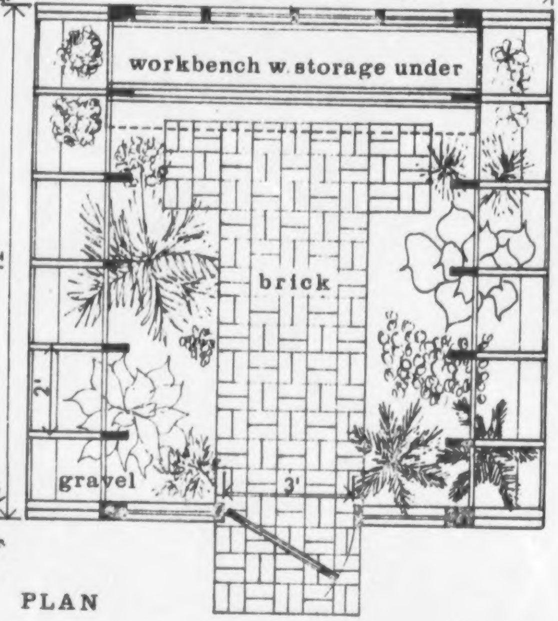


structure is redwood or treated pine

end walls - 2×4 framing w. plastic panels & louvers louvered door cut to fit


2×8
2×6
9'
11'
2×8
workbench of 2×4's
footing

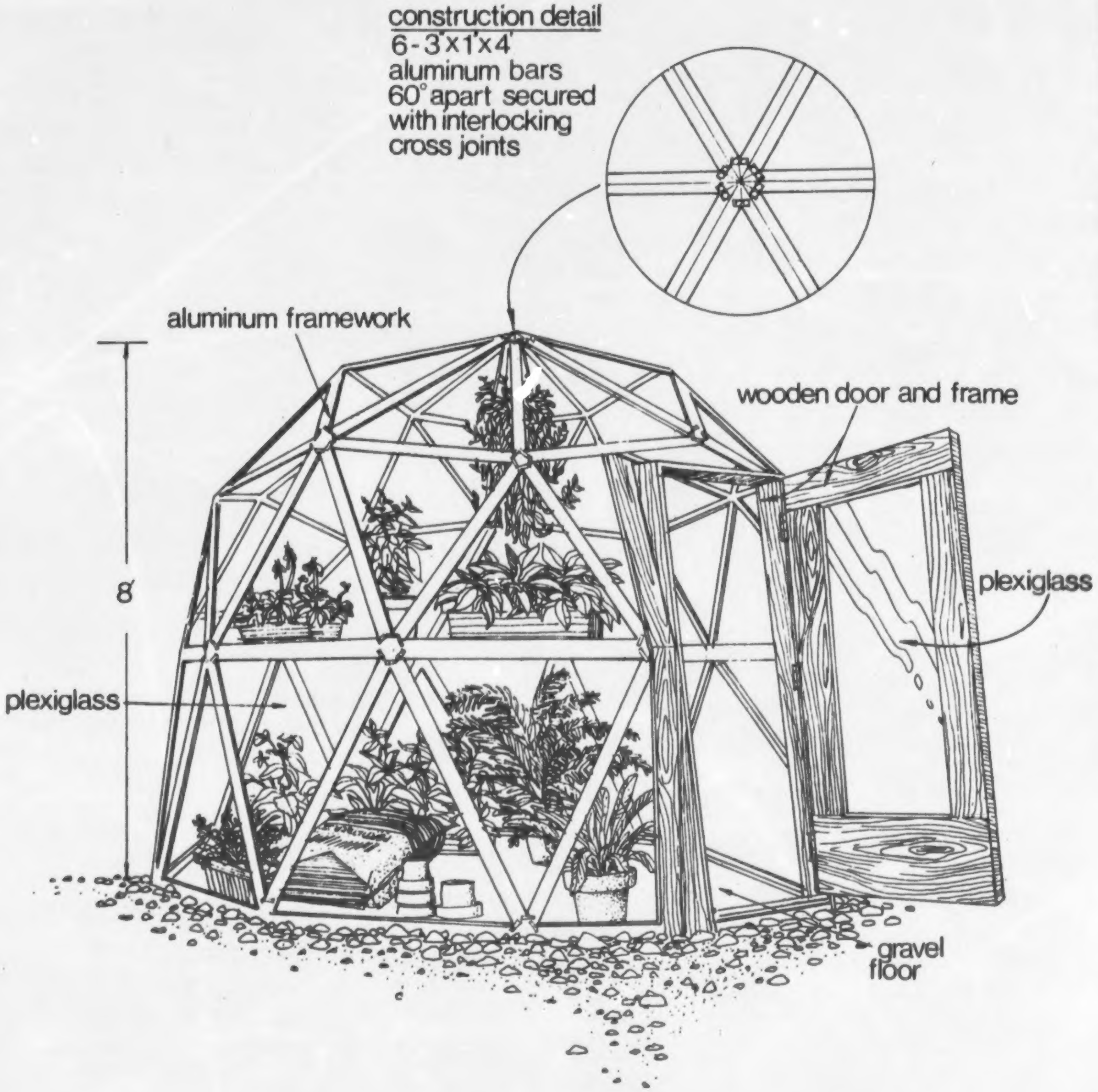
SECTION


12'
12'
workbench w. storage under
brick
2'
gravel
3'

PLAN

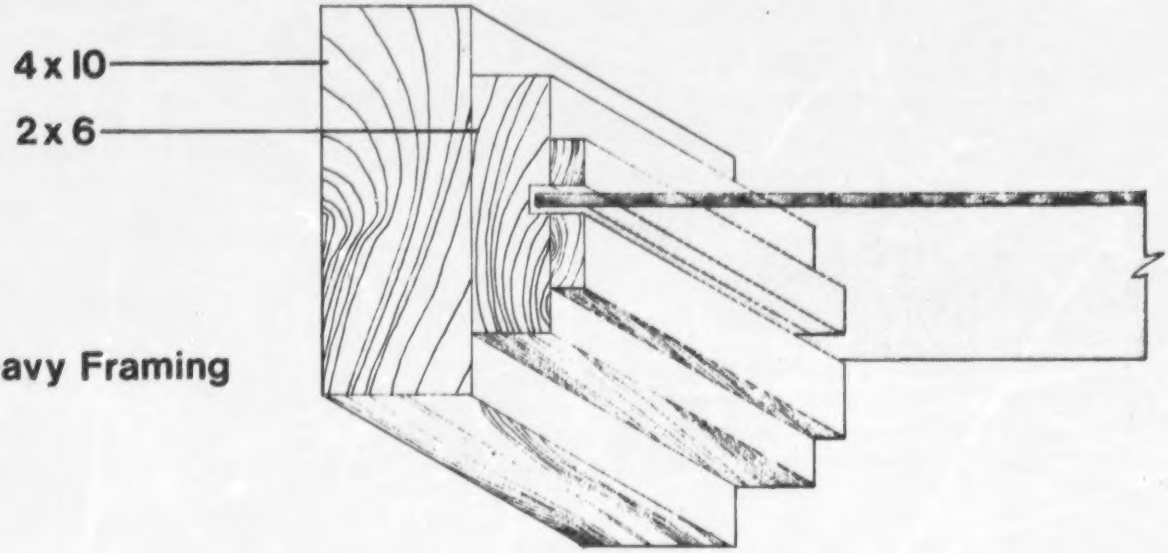
Homemade Greenhouse by Jack Kramer
Design by Adrian Martinez

DOME GREENHOUSE

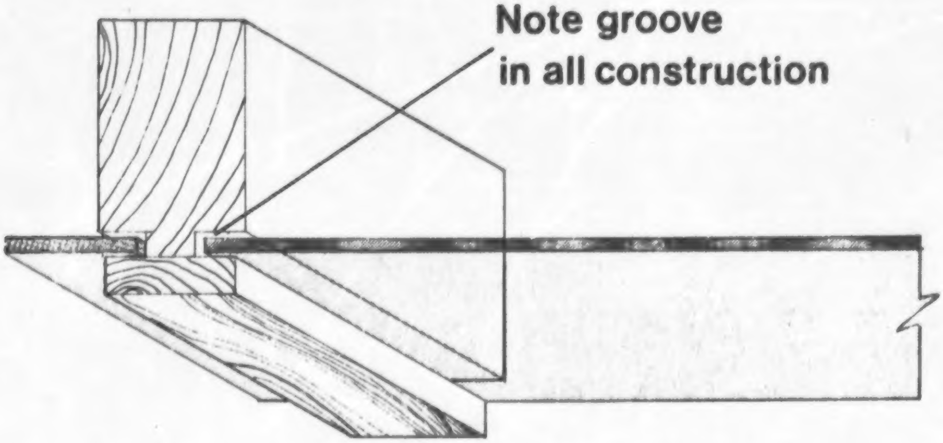

construction detail
6-3'x1'x4'
aluminum bars
60° apart secured
with interlocking
cross joints
aluminum framework
wooden door and frame
8'
plexiglass
plexiglass
gravel
floor

Homemade Greenhouse by Jack Kramer
Design by James Caren

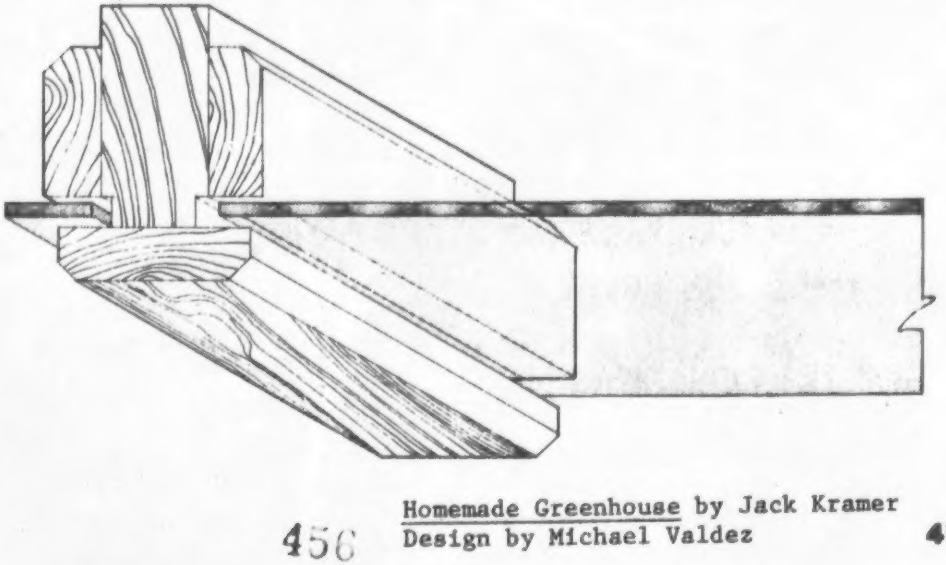
BASIC GLASS INSTALLATION - WOOD



Heavy Framing


Note groove
in all construction

Medium



Light

Homemade Greenhouse by Jack Kramer
Design by Michael Valdez

ACTIVITIES

1. Identify vegetables that can grow in your local area. Invite an experienced farmer to tell about his farming experiences. Ask him about ways to conserve energy on a farm (Activity XIII-1).

2. Plant a garden on the playground at your school and then have a feast at harvest time, or better yet, plant a garden at home with the help of your family (Activity XIII-2).

3. Build a compost outside the school or build an enclosed compost inside in a trash can or some other type of container. When the compost is ready to use, let a farmer use it or use it on your own school garden. See if it helps fertilize the plants (Activity XIII-3).

4. Visit a greenhouse and talk to the gardener about the amount of energy it takes to maintain it. Ask how solar energy helps in summer and winter (Activity XIII-4).

5. Collect and identify harmful insects. A county agent could visit the classroom to explain local methods of controlling pests (Activity XIII-5).

6. Define vocabulary words (Activity XIII-6).

Vocabulary

(Activity XIII-6)

1. compost -

2. humus -

3. nitrogen -

4. pesticides -

5. phosphorus -

6. potassium -

SUGGESTIONS TO THE TEACHER

This chapter has been prepared to provide introductory material on growing a garden. It points out the fact that producing some of your own food saves energy.

Some of the activities such as growing a garden or making a compost pile will require planning several months ahead of time, but it can be done in conjunction with a biology or botany class. The various activities should be attempted after the information section has been read and discussed, in order for the students to gain a thorough understanding of the basic concepts related to gardening. The other activities, with the exception of the vocabulary list, involve field trips or speakers in the classroom.

Growing your own garden is not essential for a successful energy conservation effort, but it helps to point out to the students that in every phase of society, conservation can be practiced.

List of Materials

Activity XIII-1

brochures or booklets from a nursery

Activity XIII-2

plot of land
shovel
hoe
garden rake
a plan for a garden
various seeds
fertilizer
water source
pesticide
any other helpful gardening tools

Activity XIII-3

Refer to discussion on soil fertilizers and composts in the information section.

Activity XIII-4

a local greenhouse
field trip provisions

Activity XIII-5

insects

Activity XIII-6

vocabulary list in hand-out form
pen or pencil

TEST

TRUE OR FALSE - Circle T if the statement is true, or F if the statement is false, correct the false word or words to make it true.

EXAMPLE: T F Americans do not waste food.
(Americans do waste food.)

1. T F Growing our own food saves energy.
*

2. T F Plants can be grown anywhere: inside your closet, in hard rock, or even under a rock.
*

3. T F Plant diseases and pests cannot jump from one plant to another.
*

4. T F Garden soil has to be dug deep before the seeds are planted.
*

5. T F It is better to grow plants that produce until the first frost hits in the fall.
*

6. Pesticides are used to:

A. build a greenhouse

B. fertilize the plants

C. water the plants

* D. kill pests including insects, weeds and plant diseases

7. Fertilizers are used to:

A. kill pests including insects, weeds and plant diseases

B. build a greenhouse

* C. give a balanced amount of proper nutrients to your plants

D. tie long, vine-type vegetables to a pole for support

8. Humus is made by

A. a factory

B. mixing nitrogen, phosphorus and sulfur together

* C. gathering up organic waste and letting it decay

D. the Humus family in Chicago, Illinois

9. A compost pile is made of

* A. vegetation, manure, soil, and some lime, if needed

B. vegetation, cotton gin waste, rocks and sandstone

C. salt, lime, manure and sandstone

D. soil, rocks, garbage and wood

10. What is a glass or plastic-covered building where temperature and humidity can be controlled?

A. a gymnasium

* B. a greenhouse

C. a conservatory

D. a closet

RESOURCE LIST

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